NATURE

Vol. 143 SATURDAY, FEBRUARY 11, 1939 No. 3615

CONTENTS

	PAGE
Agricultural Research and Education	217
State Control of Private Forests. By T. T.	219
Karl Pearson. By G. Udny Yule, C.B.E., F.R.S.	220
Protein Chemistry. By Dr. J. B. Speakman	222
Academic Psychical Research	223
Safety in Coal Mines. By Prof. J. A. S. Ritson, O.B.E.	225
Liquid Helium. By Dr. J. F. Allen and Dr. H. Jones	227
The Earthquake in Chile	230
Obituary Notices:	
Prof. H. H. Woollard, F.R.S. By Prof. W. E. Le Gros Clark, F.R.S.	231
Mr. A. B. MacDowall	232
News and Views	233
Letters to the Editor:	
Disintegration of Uranium by Neutrons: a New Type of Nuclear Reaction.—Prof. Lise Meitner and Dr. O. R. Frisch	239
A Novel Thermostat.—Prof. T. H. Laby, F.R.S., and V. D. Hopper	240
Limitations on the Modern Tensor Scheme of Relativity.—Sir Joseph Larmor, F.R.S.	240
Theory of Mesons and Nuclear Forces.—Dr. C. Møller and Prof. L. Rosenfeld	241
Frequency Interpretations in Probability.—Dr. Harold Jeffreys, F.R.S.	242
Antarctica and Glacial Ages.—Dr. Alex. L. du Toit	242
Scattering of Radio Waves in Polar Regions.—Prof. E. V. Appleton, F.R.S., and R. Naismith	243
Electric Charge on Soft Hail.—Dr. J. A. Chalmers and E. W. R. Little	244
Catalytic Exchange of Deuterium and Hydrogen in Hydrocarbons.—Prof. L. Farkas and A. Farkas	244
Availability of Phosphorus in Rice.—Dr. A. Sreenivasan	244
Self-Sterility in *Œnothera*.—Prof. R. Ruggles Gates, F.R.S.	245
Induction of Polyploidy in Chilli (*Capsicum annuum* L.) by Colchicine.—Dr. B. P. Pal and Dr. S. Ramanujam	245
Period of Gestation of *Loris*.—Dr. Lucius Nicholls	246
The 'Thumb' of the Piant Panda.—Prof. F. Wood Jones, F.R.S.	246
Electrified Motor-Vehicles.—Dr. E. C. Williams	247
Research Items	248
Isotopes of the Alkaline Earth Metals from Uranium. By R. W. L.	251
Subspecies and Varieties	252
Interstellar Space	253
H. T. de la Beche: Geologist and Business Man. By Dr. F. J. North	254
Hydrogenation of Oils by the Continuous Process	255
Science News a Century Ago	256
Societies and Academies	256

Editorial and Publishing Offices:
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London
The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

Advertisements should be addressed to
T. G. Scott & Son, Ltd., 63 Ludgate Hill, London, E.C.4. Telephone Number: City 4211
Registered as a Newspaper at the General Post Office
All rights reserved

CAMBRIDGE

ELECTRON OPTICS

By The Research Staff of Electric and Musical Industries Limited

Compiled and written by OTTO KLEMPERER

1 plate, 49 text-figures. 6s. net.

This new volume in the series of *Cambridge Physical Tracts* gives a concise account of the principles, methods, and applications of geometrical electron optics. It should be of particular value to the advanced student of experimental physics and to the research worker, but can be studied without any specialised knowledge of geometrical optics or electron physics.

Fifth Edition

VOLUMETRIC ANALYSIS

including the Analysis of Gases

With a chapter on Simple Gravimetric Determinations

By A. J. BERRY. 7s. 6d. net.

In this new edition the author has dealt with certain modern developments in volumetric analysis by adding a special chapter to the book. Two additions, one dealing with lead and the other with phosphates, have been added to the chapter on gravimetric determinations. A short chapter on the rudiments of gas analysis has also been added to the book.

UNIVERSITY PRESS

Qualities that give you Perfect Photomicrographs

★ HIGH DEGREE OF CONTRAST
★ RESOLVING POWER
★ FULL PANCHROMATISM
★ ADEQUATE LATITUDE

You get them all with the new Kodak Plate

P.25 HALF-TONE PANCHROMATIC (Wratten)

Kodak P.25 Plates are obtainable unbacked and backed. The backed variety is especially valuable when the illumination is by transmitted light, since the backing has an anti-halation effect. This backing, incidentally, dissolves in the developer in less than 30 seconds.

Wratten "M" Filter Factors for Photomicrographic Work on Kodak P.25 Plates using Tungsten Filament Illumination.

Filter	A	B	C5	D	E	F	G	H	KI
Factor	7	10	12	12	4	9	2½	12	1½

Full details of P.25, other new Kodak Plates and Wratten "M" Filters from Mr. N. Alfred, Dept. 6,

KODAK LIMITED, KODAK HOUSE, KINGSWAY, LONDON, W.C.2

Editorial & Publishing Offices :
MACMILLAN & Co., LTD.
ST. MARTIN'S STREET
LONDON, W.C.2

NATURE

Telegraphic Address :
PHUSIS, LESQUARE, LONDON

Telephone Number :
WHITEHALL 8831

Vol. 143 SATURDAY, FEBRUARY 11, 1939 No. 3615

Agricultural Research and Education

THERE can be few to-day who would deny that scientific research lies at the base of material progress. Ninety years ago or more, the Prince Consort recognized the fact ; but it was not until the middle of the Great War that the Government in Great Britain first embarked upon a comprehensive scheme of State assistance for industrial and scientific research. Agriculture was a little more fortunate, because, thanks to the perspicacity of Mr. Lloyd George, a Development Fund was established in 1910–11 which, among other objects, was designed to aid and develop agriculture and rural industries. Since that time, an increasing amount of money has been given to promote and maintain agricultural research, and in the year 1938 the State spent at least £700,000 on this object in Great Britain. This sum represents about 90 per cent of the total expenditure on agricultural research and advisory services, to which farmers themselves contribute very little, and is distributed among some fifty institutions, of which twenty-eight are devoted solely or primarily to research.

The chief recipients of grants are agricultural colleges and university departments of agriculture, which also have educational functions ; State institutions, like the Veterinary Laboratory at Weybridge, Surrey ; and private institutions, like Rothamsted, the Rowett Institute, and the Royal Veterinary College, London. There are 673 research workers at the chief institutions and the total number in Great Britain is rather less than one thousand. Propagation of the results of research, and general advisory work, are delegated to seventeen principal advisory officers located in sixteen provincial advisory centres which are usually university departments or agricultural colleges, and lower down the scale are advisory officers and agricultural organizers appointed by agricultural education committees of county councils. The councils make small grants for research to university departments, agricultural colleges and research institutes. Research is also conducted by private interests like Imperial Chemical Industries Ltd. at Jealott's Hill, and the Wellcome Physiological Laboratories at Beckenham, Kent. Lastly, there are nine Imperial bureaux and two Imperial institutes which collect and collate information and abstract the scientific literature for research workers throughout the Empire.

The above and many more interesting and relevant facts are set out in an admirable report published by P E P*, which records the findings of a special committee it appointed to examine the adequacy of the provision made for agricultural research in Great Britain, how it is administered, and to what extent the measures taken to get farmers to utilize the results have been successful. The report sees much to commend in the provisions made for agricultural research, but it is also critical, and in the interests of progress, our remarks will be confined in the main to two objects of criticism : the cumbersome machinery of administration and finance, and the failure to 'put over' the results of research to working farmers.

Responsibility for the administration and finance of agricultural research in Great Britain is divided among numerous authorities of the central Government : the Agricultural Research Council, the Development Commission, the Ministry of Agriculture for England and Wales, the Department

* Report on Agricultural Research in Great Britain : a Survey of its Scope, Administrative Structure and Finance, and of the Methods of making its Results known to Farmers, with Proposals for Future Development. Pp. vi+146. (London : P E P 1938.) 8s. 6d. net.

of Agriculture for Scotland, the Dominions Office (for the Imperial institutes and bureaux), the Privy Council, and the Treasury. This multiplicity of authorities has many drawbacks, and P E P advises that the Development Commission, which has already lost some of its initial functions, should be abolished as a piece of "superfluous stage property". Many will think that the pruning process might be extended, but excessive devotion to old forms and traditions, and a propensity to compromise, seem to be a characteristic of the governmental mind in Great Britain. Government departments are, of course, always fair game for carping critics, but more than one Government inquiry in recent years has recommended the application of the axe.

The organization of agricultural research institutes is criticized by P E P in so far as it is based too largely upon departmental science: more husbandry institutes are wanted, each of which would specialize in a particular crop or product rather than upon a particular science. The low salaries paid to research workers are deprecated, and the creation of a central agricultural research fund, with larger contributions from the industry, is advocated.

The most serious criticism against the existing order is failure to get the results of research translated into farming practice, a failure which, in our opinion, cannot be ascribed entirely to the agricultural education authorities or to the systems under which they work. Agricultural education in England is under three administrations: the Ministry of Agriculture, the Board of Education, and the county councils. From the agricultural colleges and university departments some 2,000 students pass out every year, but surprisingly few of them take up farming on their own account, either because they lack the necessary capital, or because no managerial posts are open to them; most of them take up teaching, or go into administrative service, or join the larger commercial firms.

Agricultural education for the rank and file is administered by the county councils, each of which commands the services of a county agricultural organizer, district organizers, and special instructors. The staffing varies greatly between county and county, and in general the number of instructors appears to be inadequate. Of the 22,000 students who come under the county councils, about half receive their instruction in evening classes only. In addition to itinerant teaching, the county staffs undertake demonstrations and advisory work. Education is also provided, mostly during the winter months, by the residential farm institutes, in which the teaching is essentially practical. Technical instruction is given in senior schools and in instruction classes financed by the county education committees and the Board of Education. The Young Farmers' Clubs also have educational functions; and lastly, the farming community can gather knowledge and advice from broadcast 'talks', from departmental publications designed to popularize recent advances in technique, and from the agricultural press.

With this medley of administrative organs and public and private agencies, it is small wonder that results have proved disappointing. Agricultural education, like many other institutions of the civilized world, has become far too complex, and only the surgeon's knife followed by Occam's razor can bring us back to simplicity and efficiency. P E P proposes that the county advisory services be transferred to the provincial advisory centres, but other critics would have all the agricultural educational functions of the county councils so transferred. Many would like to see a great extension of the farm institutes, which have accommodation for only a fraction of the youth destined for the land, and their utilization for short courses of instruction for skilled specialized workers.

But perhaps the greatest handicap to the spread of new scientific knowledge is the character of the farmers themselves. Farmers of the old type—they are still in a large majority—who have inherited the prejudices as well as the consummate skill of their forbears usually shy at the sight of the scientific adviser, a reaction that may be partly due to unhappy experience of projects they were induced to adopt by well-meaning but unpractical enthusiasts. On the other hand, there is arising a new generation of farmers, more appreciative and keen, who, if less skilled than their fathers in the old methods applicable to bygone conditions, are open to new ideas and thoroughly progressive in outlook. The day of the old practical farmer is passing—of the man who could himself efficiently perform all the manual tasks of the farm. He was, in essence, a farm labourer with capital. Unless we are to perpetuate peasant farming, it is as unreasonable to expect the modern, and especially the future, farmer to be an expert in the everyday jobs of the farm, as it

is now to insist on the manager of an engineering works being able to undertake all the tasks in his workshop.

As the P E P report indicates, the main hope for the future lies in reformed education in the primary and secondary schools, rather than in the higher seats of learning. Agricultural research is far ahead of agricultural education. Vocational instruction is not wanted in primary schools. The claims of English, arithmetic, geography and an outline of world history must be recognized, but more scope is required for what is termed 'general science', the teaching of broad outlines largely through applications. The pupil who is destined for the land should, we suggest, leave school at fourteen to fifteen years of age, and serve an apprenticeship lasting one to two years on an up-to-date farm, where he would be encouraged to relate his school science to the facts of farming. He should then return to school, continue his general education, and pursue a more specialized course of instruction in those sciences that bear directly upon agriculture. So trained, it is difficult to conceive of any youth, other than a 'throw-back', entering agriculture without an informed mind and a progressive outlook. Besides instilling knowledge and training the mind to think, education for agriculture, or for any other pursuit, can only be worthy of the name if it inculcates such essential social virtues as willingness to co-operate and consideration for others.

State Control of Private Forests

Forestry and State Control
By Prof. R. S. Troup. Pp. vii + 88. (Oxford: Clarendon Press; London: Oxford University Press, 1938.) 3*s*. 6*d*. net.

THE condition of private woodlands in Britain has been the subject of increasing concern ever since the British people began to realize that their former complacent reliance on continuous supplies of timber from abroad is not so well founded as they supposed. The main part of the task of building up a reserve of softwood timber in the country for use in times of emergency has been entrusted to the Forestry Commissioners, but in assigning them their share in this work, it was assumed that through their encouragement and example private woodlands, both hardwood and softwood, would be restored to their pre-War area and their productivity improved. Unfortunately, it has become evident that this assumption was not justified and, as questions of national defence, economic self-sufficiency and political interferences with the flow of trade and commerce seem to be increasing rather than diminishing in importance, it is not surprising if the advisability of taking more intensive measures in regard to private forestry has come to the fore.

The whole tradition of Britain has been against State interference with private productive enterprise, and State action as regards private forestry up to the present has been confined to attempts to induce the private owner to practise more and better forestry by propaganda, provision of technical education and advice, taxation concessions, planting subsidies and assisted marketing. In many countries, however, the action of the State goes far beyond such measures as these, and may extend to legal restrictions on felling, and insistence on the regeneration of felled areas, employment of certain sylvicultural systems, etc. The degree of control exercised may extend from mere inspection of the forests, to see that the law is not evaded, to the actual management of private woodlands by State forest officers.

In this book, Prof. R. S. Troup gives an account of the methods of control over private forests practised in the chief European countries, and discusses, in the light of knowledge gained by personal visits and inquiries, the actual working of these measures and the attitude of private owners to control by the State. The first half of the work is devoted to a general account of the nature and ownership of forests and a discussion of the question of whether, and in what circumstances, State control of private forests is justified.

After a review of the position of British forestry, the author expresses the opinion that, besides the incidence of death duties and the economic forces acting against forestry in Britain, the main cause of the poor productivity of private woodlands is the absence of adequate technical knowledge on the part of those responsible for their management. The remedy for inefficient management is the employment of properly trained forest managers, but most woodland estates are too small to justify

the appointment of a whole-time manager; the difficulty might be got over by a scheme of co-operation by which a number of estates would be placed under the charge of a single manager. Subsidies would be better devoted towards improving sylviculture and forest management (including planting) than towards encouraging planting alone. The author finds it difficult to see how any permanent improvement in private forestry in Britain is possible without some form of compulsion and State supervision, in return for which it may be necessary to offer further concessions and assistance to landowners. "Legislation directed towards imposing State control, should aim at preventing, rather than encouraging the break up of estates; it should avoid penalizing well managed estates, but should aim rather at bringing others into line with them."

As Prof. Troup remarks, it must be admitted that the question of reforming private forestry in Britain is one in which it is easier to indicate the ideal to be attained than to devise workable measures for carrying it out. If the time should come when it is adjudged necessary to formulate legislation for the purpose, the information as to the methods adopted and experience gained in other countries, set out in the second part of this book, should be of the utmost value. These measures naturally vary greatly from country to country, according to geographical situation, social and economic conditions and past history. Perhaps the most interesting to us are the forest laws of Denmark, which approaches most nearly to Britain in the smallness of its forests and the nature of its government. Most of the woodlands of Denmark are 'reserved forests', and they must be maintained under a high forest crop, the proportion of hardwoods must not be diminished, fellings must be succeeded immediately by afforestation and the crops managed under approved sylvicultural principles. Inspection by State forest officers ensures the carrying out of these provisions. Speculation in woodlands is checked by a law that, after a sale of reserved forest, the purchaser, for a period of ten years, can only make fellings necessary for the domestic use of the estate or for the proper management of the woods (sustained yield). On the other hand, reserved forests are subjected to lower land taxes, and State assistance is given by providing technical advice.

Though control in Denmark is strict, there are remarkably few complaints from landowners, and this appears also to be generally the case elsewhere. The limitation of the freedom of the owner is compensated by the benefit he obtains financially from properly managed woodlands and his sense of security that his forests will not be devastated by his successors in title.

Prof. Troup has succeeded in presenting in a limited space a great deal of information which has hitherto not been easy of access and will be welcomed, not only by students of forestry but also by a wider public. T. T.

Karl Pearson

Karl Pearson:
an Appreciation of some Aspects of his Life and Work. By E. S. Pearson. Pp. viii + 170 + 9 plates. (Cambridge: At the University Press, 1938.) 10*s.* 6*d.* net.

THIS handsome volume is a reprint of two articles recently published in *Biometrika* (vols. 28 and 29), with the addition of a couple of extra appendixes giving respectively the full syllabuses of Karl Pearson's Gresham College lectures on statistics during 1891–94, and notes of his lecture-courses on that subject at University College, London, in 1894–95 and 1895–96. The author asks "that wider audience" to which the memoir is now made available to bear in mind that it is "in no sense a Life" of his father. That seems to be going a little too far. In so far as a man's labours *are* his life—and for Karl Pearson they were that to a greater extent than for most men—this is an admirable Life: brief certainly, with plenty of room for filling in details, but well-ordered, and very readable at all events by the statistician, to whom it is mainly addressed, much being inevitably more or less technical. But there is more in it than this. Portraits, letters, lighter sketches of life on vacation or in the laboratory, and friendships, serve to fill in the human side of the picture.

Prof. Pearson divides the life into nine periods into which it naturally seems to fall. 'K.P.' was born in 1857. The early years of school and university carry us to 1879, and there is a delightful portrait (Plate II) of the schoolboy Karl. Then came the wander-years, 1879–84, the years in Germany, the years of historical research and of many lectures afterwards collected in the "Ethic of Freethought"; the years of "The New Werther"—

a most interesting revelation this, 'K.P.'s' first published work and a striving after a creed of life; and of "The Trinity: a Nineteenth Century Passion Play". This period closed with his election to the chair of applied mathematics and mechanics at University College, London, in June, 1884, at the early age of twenty-seven years. The first years of his occupation of the chair, from 1884 until 1890, apart from the heavy work of preparing and delivering his over-numerous lectures and supervising the drawing-classes in connexion with them, must have been largely dominated by the "History of the Theory of Elasticity" and "The Elastical Researches of Barré de Saint-Venant"; but the period covers also some of the later lectures of the "Ethic".

Then came the publication of Galton's "Natural Inheritance" in 1889 and the appointment of Weldon to the chair of zoology at University College in 1890, and 'K.P.'s' main energies were step by step diverted into the channel in which they were to flow for the remainder of his life, though it was still to be some twenty years before all the labour of the lectures to engineers and B.Sc. students could be dropped. They were years of incredible activity. In 1892 came the "Grammar of Science", in 1893 vol. 2 of the "History of the Theory of Elasticity". Then, during the same years, there were the Gresham Lectures, and from 1893 onwards the succession of fundamental memoirs in the *Proceedings* and the *Transactions of the Royal Society* in which the foundations of modern statistical methods were laid. In 1900 came the rediscovery of Mendelism, and the unfortunate controversy that followed in connexion with the Evolution Committee of the Royal Society. In 1901 *Biometrika* was started, and there followed several years in which much active work was done in the collection of data relating to inheritance.

The tragic death of Weldon in 1906 brought this period to a sudden end, and, as the author says, seems to have made a definite dividing line in his father's life: thereafter there was less biology and more theory of statistics, more miscellaneous papers, in his output. Galton's death in 1911 made another break. By the foundation of the Galton professorship of eugenics, 'K.P.' was at long last, after twenty-seven years' tenure of the post, enabled to resign the chair of applied mathematics, and the diversion of energies it had entailed came to an end. But not for long was he to have leisure and opportunity for developing the new department and celebrating its founder in the magnificent "Life, Letters and Labours". War came in 1914, and with the war the diversion of all available staff to war-work: the strain, heavy enough in itself, was made the heavier by inevitable anxiety as to the future. Revivification, however, came rapidly with peace. Funds to meet the enormous rise in building costs were obtained from one source and another, the new laboratory arose, and the years from 1920 until his retirement in 1933 saw a steady output of work and an activity that is truly amazing when 'K.P.'s' age is recalled. Retirement left but a brief space, still spent in activity, before death came with merciful suddenness in the spring of 1936.

There was no one like 'K.P.' in his generation. To find his like I think one must go back to the seventeenth century: in many respects—in his outstanding ability, his width of knowledge and interests, his energy, his complete self-confidence, his 'trespassing' into divers fields, and his continual immersion in controversy from early manhood almost to the grave—John Wallis not a little resembled 'K.P.'.

Prof. Pearson has well acquitted himself of the task within the limits he set. In each period the work that mainly dominated it is clearly set out and the principal memoirs discussed. In particular his treatment of controversies, which must often have been difficult, is highly to be commended for its balance and restraint. Here I would like to make one comment, thinking less of the past than of the present and the future. "Writers rarely . . . understand," wrote 'K.P.' in 1914 (p. 66), "the almost religious hatred which arises in the true man of science when he sees error propagated in high places." Surely neither in the best type of religion nor in the best type of science should *hatred* enter in at all. One may appeal to the earlier 'K.P.' who wrote of the freethinker ("Ethic", p. 22), "he has no right to abuse, he can only endeavour to teach". In one respect only has scientific controversy perforce improved since the seventeenth century. If *A* disagrees with *B*'s arguments, dislikes his personality and is annoyed by the cock of his hat, he can no longer, failing all else, resort to abuse of *B*'s latinity, cf. Hobbes *v.* Wallis.

To those of us who knew the living man, such a memoir as this shows us some aspects of him that we could not have known or did not know, and other aspects, that we did know, seen by another eye from another point of view. We are grateful for Prof. Pearson's work. But there is a younger generation who scarcely knew him, or did not know him at all, to whom he is only the shadow of a name, to whom even his work is known only at second hand or at third, seen through the distorting medium of text-books. It is to be hoped that this younger generation of statisticians will read and digest the memoir, and make use of the select bibliography it contains. It will do

much to enable them to visualize the man who founded modern methods in statistics and will, it is to be hoped, send them back from text-book statements to the original sources. Let it be added that the price is very low for so handsome a volume with its wealth of portraits—though there isn't one of the Karl who returned from one summer vacation (somewhere about 1888, I think) to startle his class with the possession of a beard like a Viking.

G. UDNY YULE.

Protein Chemistry

Chemistry of the Proteins

By Dr. Dorothy Jordan Lloyd and Agnes Shore. Second edition. Pp. xi+532. (London: J. and A. Churchill, Ltd., 1938.) 21*s*.

DURING the twelve years which have elapsed since the publication of the first edition of this book, the constitution, structure and properties of the proteins have been studied by an ever-increasing number of workers, employing every available method of experiment. Fundamental and far-reaching advances in knowledge have been made, and the volume under review, which includes references to most of the papers published up to the end of 1936, as well as a few in later years, is considerably larger than the first edition.

The general plan of the original book has been retained, except that two minor chapters, dealing with the industrial uses of the proteins, have been omitted, and a few of the remaining chapters re-arranged. In the preface to the second edition, the authors express regret at having had to omit references to the industrial aspects of protein chemistry, but the decision was certainly wise, because adequate treatment would demand a separate volume for each industry, and some such volumes are now available. On the other hand, the co-ordinating effect of recent advances in knowledge is such that the point of subdivision of the book into two parts is both artificial and unnecessary.

The new volume, like the old, commences with a survey of the nature and properties of the amino acids. This is followed by an outline of the biological classification of the proteins in a chapter which reflects both the former empiricism of the subject and the clarification which has resulted from recent research. Besides being greatly enlarged, the succeeding summary of available methods of protein analysis is a model of lucidity, as is the account of the methods used for establishing the homogeneity and identity of the proteins. The relationships between constitution and nutritional value are discussed in a section which includes an excellent summary of the work of Rose and his collaborators, and the obscurity which has cloaked the subject of indispensable amino acids seems now to be disappearing.

A brief but interesting survey of the nature and classification of the enzymes, including a summary of Bergmann's work with simple peptides, forms an excellent introduction to the consideration of molecular size, structure and shape. It is here that the influence of recent research is most strongly felt, and due consideration is given by the authors to the results of X-ray and ultra-centrifuge methods of experiment, as well as the more theoretical treatment of Wrinch and Bergmann. The manner in which these several methods of reasoning and experiment concur in revealing an ordered arrangement of amino acids in the protein molecule, and in fixing its size, is so striking that little regret need be felt that the authors were unable to emphasize the general agreement by considering the subjects of osmotic pressure and protein films in the same chapter. In the remainder of the book, the structure of the protein molecule, so far as it is known, is made the basis of a discussion of combination with acids and alkalis, the related phenomena of osmotic pressure and swelling, denaturation, and the theory of protein solutions. As regards the concluding chapter, which contains a number of misprints, it is difficult to avoid the conclusion that the authors might have increased the cogency of their argument by including the subject-matter in appropriate earlier sections of the book.

Besides being a lucid and concise survey of the present state of protein chemistry, the volume includes exhaustive lists of references, and there can be no doubt that it will be even more welcome than its predecessor. The authors' treatment of the subject is sufficiently, but not unduly, coloured by their own views to make interesting and provocative reading, and, in the words of Sir Frederick Gowland Hopkins's introduction, "even the specialist . . . may well find as the result of reading this book that the fertile mating of facts, which for him were previously disconnected, has yielded him a progeny of happy suggestion for research".

J. B. SPEAKMAN.

Academic Psychical Research

(1) Science and Psychical Phenomena
By G. N. M. Tyrrell. Pp. xv+379. (London: Methuen and Co., Ltd., 1938.) 12*s.* 6*d.* net.

(2) Psychical Experiences
Evidence of Purpose. By Zoë Richmond. Pp. viii+112. Foreknowledge. By H. F. Saltmarsh. Pp. viii+120. Ghosts and Apparitions. By W. H. Salter. Pp. vii+138. Hypnosis: Its Meaning and Practice. By Eric Cuddon. Pp. viii+169. 3*s.* 6*d.* net each. (London: G. Bell and Sons, Ltd., 1938.)

TO the impartial and independent observer, the relations between psychical research and spiritualism are always of interest. The one can scarcely be active without the other: co-operation is often urged and as often rejected; and a kind of armed neutrality is the result. The more earnest psychical researchers are perfectly well aware that as long as they support and treat with consideration the large number of dubious mediums who prey upon the credulous, their own claims to serious attention are put in jeopardy; whilst the spiritualists demand from them something more than passive inaction as the price for the privilege of investigating the more promising cases.

In the last ten years, a gradual separation has been taking place, for the psychical researchers have now become fully aware that the scientific citadel is not to be stormed by the motley crowd, which has for so long formed a part of their supporters. Not only the method of approach but also the subject matter itself has had to undergo revision. For the time being, the scientific world is not to be presented with accounts of floating tables and phantoms looking as if they were made of chewed paper. It is hoped that better success will be achieved by statistical formulæ and philosophical disquisition. An illustration of these tendencies can be seen in the five volumes now under review.

(1) Mr. Tyrrell, in his summary of a good deal of the field included under the term 'psychical research', has given us one of the best surveys so far published. No one who reads this persuasive and thought-provoking volume can fail to be impressed by the author's obvious sincerity and enthusiasm; neither can he fail to conclude that if this be psychical research, then it is indeed strange that the scientific world remains so aloof and seemingly unfriendly. For here he will find, set out in orderly sequence, accounts of the principal mental phenomena, graded under such terms as telepathy, clairvoyance, precognition and retrocognition. After past work is viewed from its historical aspect, the more recent cases, both spontaneous and experimental, are examined and criticized. In the latter part of the book the philosophical and psychological implications are described; and the problem of the nature of human personality is considered in its relation to the phenomena which have been discussed.

(2) If Mr. Tyrrell's book be regarded as an admirable text-book for study, then the other volumes, the titles of which are noted above, can be used as supplements, containing as they do additional cases and discussions. This new series is really a highly condensed selection of material published for the most part in the *Proceedings* and *Journal of the Society for Psychical Research*. Thus the student who wishes to become acquainted with the best cases the Society has to offer cannot do better than read these books, and then, if he wishes, he can go back to the original sources for additional information.

It can scarcely be denied that, viewed as attempts to claim scientific recognition, these volumes are of great interest. To one wholly untrained in psychical research and with no knowledge of what lies behind much of the impressive façade, the effect must be considerable. Only careful analysis and years of experience will weaken that effect, for it is but here and there that the authors under review cite cases as good, which are so clearly full of flaws that suspicion of their critical faculties is aroused. Moreover, the difficulty of appraisal is increased when it is remembered how hard it is to obtain repetitions under varying conditions, and how disinclined experimenters in this field generally are to permit critical and well-informed persons to test their results and examine their evidence.

This does not by any means imply that the value of the evidence here so carefully collected is worthless. But it does suggest that extreme care should be exercised before accepting fully the claims made by these writers and by others like them. Psychologists would do well to remember that these obscure problems belong properly to their own studies; and a neglect of them merely indicates a wish to remain in ignorance of some of the more important aspects of human mental activity. To them, therefore, these volumes can be heartily recommended as text-books, which illustrate better than most what serious psychical research is and what its exponents are doing.

The Kandy Flora

By A. H. G. Alston. Pp. xvii+109+101 plates. (Colombo: Government Record Office, 1938.) 3.50 rupees.

THIS is the first of four local Floras proposed for the island of Ceylon. It was actually ready in 1928, but financial stringency dictated its being withheld until 1938. The area comprised is "all the country within easy walking distance of Kandy" at an average elevation of 1500 ft.

Naturalized aliens as well as all known native phanerogams are briefly described, with the exception of the representatives of the Eriocaulonaceæ, Cyperaceæ, and Gramineæ which, together with the cryptogams, are merely listed in an appendix. The commonly cultivated plants are mentioned without description. Short descriptions of the 98 families (101 including the three mentioned above) and the genera are given. There is a handy artificial key to the families, which, so far as the Dicotyledons are concerned, are arranged according to the phylogenetic scheme of Dr. J. Hutchinson. The sequence for the Monocotyledons is that of the "Pflanzenfamilien". Generic keys are provided for each family with more than one genus, and for each genus represented by more than one species. Altogether 501 species of flowering plants (excluding the cultivated) are included, and 299 cryptogams are listed. Vernacular names are cited for most of the species. A glossary of botanical terms and a comprehensive index are provided. Finally, 404 of the species of phanerogams are illustrated by good, if rather small, drawings, mostly accompanied by enlargements of floral or other distinctive features.

As is to be expected from the author of the supplementary volume to Trimen's "Handbook of the Flora of Ceylon", the nomenclature is up to date, at least for 1928. The printing is good and the general 'get up' quite satisfactory, but the format might have been smaller for easy transport in the field. Mr. Alston is to be congratulated and thanked for producing a work that will be most useful to field workers in the area, and it is to be hoped that the project of the remaining three Floras will not be allowed to lapse or be delayed for long.

Textbook of Organic Chemistry

By Prof. George Holmes Richter. Pp. viii+711. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1938.) 20*s*. net.

THIS book is designed for "ambitious students who wish to study beginning organic chemistry and gain more than a superficial knowledge of the subject". The author confesses that he has presented more material than can perhaps be covered in an average one-year course: some of it, indeed, would be deferred in Great Britain until the student had entered his honours year.

A short introductory chapter (3 pp.) is followed by a systematic description of aliphatic (451 pp.), aromatic (190 pp.), and heterocyclic (33 pp.) compounds. Alicyclic types are omitted. Although, on the whole, the treatment is sound, the ambitious beginner will need to make great strides in order to keep pace with an exposition which introduces full structural formulæ for vitamins A and D, cholesterol, and ergosterol, on pp. 78-79. Such statements as "van 't Hoff and Le Bel . . . were the first to suggest that the structure of the carbon atom was a tetrahedron" (p. 319) could be improved; and in the following instance (p. 324) the text is misleading: "The crystallization of a racemic mixture may lead to either one of two results: the crystals separating from the saturated solution may be a mixture of the crystals of the individual enantiomorphs; or the crystals may be the molecular complex . . . if the latter situation obtains, crystallization at a higher temperature will usually cause the molecular compound to break up into the two components which separate as individual crystals".

The book is well produced, with clearly printed formulæ. J. R.

British Coracles and Irish Curraghs: with a Note on the Quffah of Iraq

By James Hornell. (Published for the Society for Nautical Research.) Pp. xii+168+23 plates. (London: Bernard Quaritch, Ltd., 1938.) 7*s*. 6*d*. net.

IN this volume, Mr. Hornell reprints a series of articles which appeared originally in *The Mariner's Mirror*, the official publication of the Society for Nautical Research. It is, he points out, the first connected account of these interesting survivals of the primitive British boats, the coracle and the curragh, which are still to be seen on the rivers of Wales and the Welsh marches, and on the west coast of Ireland. In England and Scotland they are now extinct. The English coracle, the author holds, has a common ancestry with the quffah of Iraq, but is not related to the Irish curragh. This latter is of composite origin and a product of an indigenous Celtic development. Mr. Hornell discusses details of construction with the thoroughness he has taught us to expect from him in his studies of canoes and other craft.

The Universe of Science

By Prof. H. Levy. (The Thinker's Library, No. 67.) Revised and Expanded. Pp. xiii+242. (London: Watts and Co., 1938.) 1*s*. net.

THE publication of this inspiring essay in a popular series makes Prof. Levy's views accessible to a much wider public. This is in keeping with the author's main thesis that science is not something mysterious, but a weapon forged by men to extend control over Nature; and that as such it should be a mental and material possession of the common man. Even those who have read the first edition of this work will find it refreshing to ponder again over Prof. Levy's views on the processes of science, on the nature and role of mathematics and on determinism. At a time when the wealth of scientific discoveries is apt to confuse the mind of specialists and laymen as to the value of our knowledge, books such as the "Universe of Science" can perform a useful service in orientating and encouraging constructive thought. T. G.

Safety in Coal Mines

ON December 14, 1935, a Royal Commission under the chairmanship of Lord Rockley was appointed to inquire into what steps could be taken to improve the health and safety of workers in coal mines in Great Britain, having regard to the many changes that have taken place in organization, equipment and experience gained since the Coal Mines Regulation Act of 1911. The Commission held fifty-two public meetings, and after hearing evidence from the principal interests concerned, as well as visiting a number of mines, presented its report in December last*. The Government has announced that it has accepted the report as the basis for new legislation. The report itself extends to about 250,000 words and, in addition to a volume of appendixes, 1,500 pages of evidence involving nearly 37,000 questions and answers have been published.

Though lengthy and containing many details the report of the Commission is in general unanimous; the few reservations do not to any material extent affect its general tone. It is divided into twelve chapters each of which deals thoroughly with a phase of mining legislation or practice. The Commissioners have not examined exhaustively the details of the existing acts and regulations which form the present safety code, but instead have endeavoured to give the industry a new start by appealing to its sense of co-operation. They have attempted to frame a scheme for promoting a higher standard of safety which shall be positive or constructive rather than merely prohibitive or restrictive. The report is a considerate and reasonable document which in many respects differs fundamentally from the reports of the Royal Commissions on which the 1887 and 1911 Coal Mine Acts were based. These relied largely on compulsory compliance with rigid rules and regulations and tended to place the technical officers of the Department in the invidious position of being regarded by the industry as detectives instead of technical advisers.

If the suggestion of the Commission is to have any effect in reducing the accident rate in mines, a change of attitude to each other by all the partners in the industry, namely the administration, now the Mines Department of the Board of Trade, the coal owners, the colliery officials and the work people is essential. The point is emphasized that the problem of safety in mines, if substantial improvement is to be secured, must be attacked simultaneously from all sides by adequate strengthening of the administration, the setting of a higher standard of enforcement or observance of regulations, an improvement in the material conditions under which work is carried out, and the co-operation of all parties. This will have the effect of imposing heavy duties on the shoulders of the administration and inspectorate, and heavy obligations on the owners and managing officials.

The majority of mine owners, engineers and workmen do everything that is humanly possible to encourage and maintain safe working conditions; but there remain some who, while paying lip service to the ideals, fall far short of them in practice. Until the standard of professional conduct of everybody working in coal mines rises to such a peak that deliberate evasion or lack of enthusiasm in enforcing safety principles is ostracized, no safety measures will be wholly effective. (By 'professional' is meant all classes, owners, managers, engineers, officials and workmen.) The only alternative to this voluntary change of attitude is a coercive policy as exemplified by 'thousands of regulations' or 'hordes of inspectors', a policy that the vast majority of mining men regard with despair.

The science and art of mining is in a state of constant change; quite literally, nothing is ever static in a mine, and it is to be hoped that the Mines Department, when framing the new Coal Mines Bill which will be drafted as the result of the Commission's deliberations, will pay due consideration to the recommendation that the Bill itself should be concerned with principles only, details being dealt with by orders and regulations which can be amended from time to time without having recourse to Parliament to meet the changing conditions in mines.

After a general introduction, the report gives a historical summary of the development of safety legislation in mines and traces briefly the origin and subsequent history of the mines inspectorate of Great Britain. It then goes on to discuss in detail various phases of mining organization, methods of working and ancillary operations as well as problems concerned with the preservation of health and the prevention of industrial diseases.

It is proposed that both the administrative staff at the Mines Department and the inspectorate should be strengthened and reorganized with a view of giving the Department and the inspectors a bigger sphere of activities, greater authority, wider powers and better opportunities of keeping in touch with the research stations. It is hoped

* Royal Commission on Safety in Coal Mines Report. (Cmd. 5890.) Pp. xxxii+520. (London: H.M. Stationery Office, 1938.) 7s. 6d. net.

that the senior inspectors will then be able to keep in closer personal touch with the mines in their districts and that, because of their opportunities of gaining wide experience of various mining problems, they may come to be regarded even more in an advisory capacity than has in fact been the custom heretofore. The chances of promotion and suggested general all-round increase in salary, combined with appointment by selection after interview instead of by written examination, ought to attract more experienced and better trained recruits into the ranks of the inspectorate. In the past, many men who wanted to become inspectors of mines, and if selected would have made good inspectors, have been afraid to enter into open competition against younger men owing to the time that has elapsed since they studied the fundamental sciences.

At the present time, the Mines Department, through the Board for Mining Examinations, controls the examinations for the certificates of competency that have to be held by colliery managers and under-managers in Great Britain. The Board was subjected to two kinds of criticism from witnesses, (*a*) against its present constitution, and (*b*) against the character of the examinations. It was pointed out that there is no system of rotational retirement and that no representative of any education authority or class of official other than the mine manager has a seat on the Board. The complaint about the character of the examinations was that they may allow candidates to pass without showing any real evidence of adequate scientific training. The Commissioners recommend the extension of statutory certificates to several other classes of officials besides managers, under-managers and surveyors and, as a consequence, propose that the present Board be reorganized into a central controlling board of seven members who shall retire in rotation. They further recommend that the Board might accept as fulfilling part of their requirements the examinations held by various technical societies or institutions. They also suggest that the new board should investigate the principle of compulsory attendance, by every candidate, at his local technical school or other institute. The Commission's second recommendation at present applies particularly to institutions which cater for officials junior to the colliery manager. The institutions concerned with other branches of engineering have their own professional examinations, but the Institution of Mining Engineers has so far held back.

The Commissioners have examined the whole question of mining research and suggest that a central research organization under the control of the Secretary for Mines ought to be an integral part of the Mines Department, with arrangements for interchange and close co-operation between its staff, the staff of the Department's Testing Station and the inspectorate; at the present time, research in the mining industry is mainly financed by grants from the Safety in Mines Research Board, though a separate organization is maintained by the British Colliery Owners' Research Association, and numerous items of local interest are investigated by individual mining engineers and institutes.

The value of research is realized by the mining industry, but the results are not so well co-ordinated as they might be and take a long time to reach the individual colliery manager. Another point emphasized is that the majority of mining research work can be divided into two complementary sections, namely, that carried out in the laboratory and that in the mine respectively. The Commission is aware that a vast amount of possibly valuable information obtained in the laboratory at the research stations has not been translated into practice, and thinks that the Mines Department, through its research organizations, should be responsible for making arrangements for testing out in practice the results obtained in the laboratories. In this respect the close co-operation of the inspectorate would be invaluable.

Another matter of general interest in the report is health; and in particular silicosis, the incidence of which has greatly increased in recent years in portions of the South Wales coalfield. The Commissioners have recommended the use of definite and well-tried palliatives but, in view of the widespread, in fact international, interest that is being taken in the question, have not been too rigid in their conclusions. They are further agreed in recommending strongly that the Mines Department should employ a sufficient staff to ensure that the problem is pursued with the utmost vigour.

The Commissioners also recommend that a permanent 'General Staff' should be formed at the Mines Department with an advisory committee representative of all interests concerned to stimulate local safety propaganda, to collect, digest and circulate to similar voluntary organizations in each coalfield, material and ideas for a continuous safety campaign. They add that the principle of medical examination and certificates of fitness before employment should be applied to all young persons, and the minimum age of entry into a mine should be raised from fourteen to fifteen years. They also direct attention to the need of systematic training for all new entrants into the mining industry.

In the Commissioners' opinion, the amalgamation of mines into large and singly-owned groups renders necessary a redistribution of the statutory responsibilities of owners and managing officials,

so that the responsibility for safe working shall be fixed on those who have the effective powers of control and not solely, as at present, on the technical employees. Among the many technical recommendations relating to mining practice are important proposals for laying down and maintaining more definite standards of ventilation, for improving and intensifying the system of supporting the underground workings and securing the general application of the principles of roof control, which have been the subject of much recent research work, for improving the physical and material conditions under which haulage operations are conducted below ground, and for strengthening the precautions in connexion with explosives, electricity, shot-firing and coal dust.

In conclusion, while doubtless many of the recommendations of the Commissioners will be hotly debated when the new Bill is passing through the House of Commons, its most bitter opponent must acknowledge that the Commissioners have carried out their difficult task with moderation and vision. They have attempted to be helpful to everybody engaged in the production of coal, and appear to have held the scales of equity admirably. J. A. S. RITSON.

Liquid Helium

By Dr. J. F. Allen, Royal Society Mond Laboratory, and
Dr. H. Jones, Imperial College, London

THE properties of liquid helium can best be considered under two headings: (*a*) properties in thermal equilibrium, (*b*) transport effects. The equilibrium properties, which have been the subject of many careful investigations in Leyden and elsewhere, may be regarded as fairly well established. These include the determination of the specific heat for different temperatures, the variation of density with temperature at different constant pressures, and the relation of the saturated vapour pressure to the absolute temperature scale. The investigations of transport effects such as the flow of the liquid through tubes, heat conductivity and associated effects are still in an early stage of development, and no clear understanding of these phenomena has yet been reached. The subject was discussed at a meeting following the International Refrigeration Congress in July and also during the Cambridge meeting of the British Association. In this article we shall confine our attention largely to the interesting newly discovered transport effects, and give an account of recent experiments the results of which at present seem to find general acceptance.

Equilibrium Properties of Liquid Helium

Helium at atmospheric pressure liquefies at 4·22° K.; the critical temperature is 5·2° K. Generally speaking, the temperature range over which the properties of liquid helium have been measured extends only down to 1° K., since this is the lowest temperature conveniently reached by lowering the vapour pressure over the surface of the liquid. At 2·19° K. under its own vapour pressure, liquid helium undergoes a remarkable transformation. As the liquid is cooled through 2·19° K., the specific heat jumps suddenly from a value of 0·4 cal. per gm. per degree to more than 5 cal. per gm. per degree, thereafter falling rapidly, approximately as T^3. Simon has recently shown that at very low temperatures (0·02°–0·05° K.) produced by adiabatic demagnetization of iron ammonium alum, the specific heat of liquid helium varies as T^3.

The transformation at 2·19° K. has also a remarkable effect on the expansion coefficient of liquid helium. Above that temperature it is positive, while below it is negative, although there is no discontinuity in the value of the density itself at 2·19° K.

Phase transformations of the type that liquid helium undergoes at 2·19° K. are known in other branches of physics; for example, the Curie-point transformation of a ferromagnetic, the order-disorder transformation of certain alloys, and the transition between the superconductive and the normal state of a metal. The temperature of the transformation in liquid helium is known as the λ-point, a name introduced by Ehrenfest. The modification of the liquid below the λ-point is generally referred to as helium II, that above the λ-point as helium I.

Liquid helium at 1° K. can be solidified under an external pressure of 25 atmospheres. At higher temperatures, greater pressures are required to produce the solid. The properties of liquid helium I are such as would be expected of an ordinary liquid of very low boiling point. It is far otherwise with liquid helium II. In the first place, it is an

immediate inference from the phase diagram that liquid helium II under its own vapour pressure remains liquid at absolute zero, for even in the neighbourhood of 1° K. the boundary line between the solid and liquid phases tends to become parallel with the temperature axis at a pressure of approximately 25 atmospheres. Since dp/dt (the slope of the boundary line) approaches zero as the temperature is lowered, and since the volume change, Δv, is not zero, it follows from Clapeyron's equation $dp/dt = \Delta s/\Delta v$, that Δs, the change in entropy on passing from liquid to solid, also approaches zero. There can thus exist the paradoxical situation of a liquid with zero entropy. On this account the possibility has been considered by several investigators that condensed helium at absolute zero has a space-ordered structure, and that the λ-point is of the nature of an order-disorder transformation.

An experimental investigation of this point has been carried out by Keesom and Taconis. They examined the reflection of X-rays in a column of liquid helium II at about 1·6° K., as well as in helium above the λ-point. No essential difference between the reflections in the two cases could be observed. Confirmation of the space-ordered theory, therefore, is still lacking, although it should be borne in mind that at 1·6° K. an appreciable degree of disorder would in any event be expected.

We may mention here that F. London, in a very interesting letter to NATURE, has recalled a prediction by Einstein that a perfect Bose gas at sufficiently low temperatures should show a discontinuity in the temperature derivative of the specific heat. Applying Einstein's formula to liquid helium, London shows that the discontinuity would occur at 3·09° K. Although Einstein's discontinuity is only in the temperature derivative of the specific heat, not in the specific heat itself, London suggests that there may be some connexion with the λ-point of liquid helium. The advantage of such a theory of the λ-point is that it appears not to necessitate a space-ordered structure for the liquid at low temperatures.

TRANSPORT EFFECTS

Flow Phenomena. Experiments designed to measure the viscosity of liquid helium II have led to the most surprising and apparently contradictory results. The first attempt in this direction was made at Toronto by Burton and Misener, who measured the damping of an oscillating cylinder immersed in the liquid. The value for the viscosity was found to drop suddenly at the λ-point from approximately 10^{-4} c.g.s. units for helium I to 10^{-5} c.g.s. units for helium II. Recent and more precise measurements by the similar method of an oscillating disk, made by MacWood at Leyden, give values varying from 3×10^{-4} c.g.s. units for helium II just below the λ-point to 2×10^{-4} c.g.s. units at 1·1° K. Liquid helium II thus appears to be very much less effective in damping the motion of a body immersed in it than helium gas at room temperature.

Attempts to measure the viscosity of helium II by measuring the rate of flow through a tube were first made by Kapitza* and by Allen and Misener in the Royal Society Mond Laboratory at Cambridge. On account of the anticipated low viscosity, the latter used very narrow tubes to lessen the rate of flow, with the extraordinary result that the rate of flow was far in excess of what would occur in a liquid of viscosity 10^{-5} c.g.s. units. Moreover, the velocity of flow did not vary linearly with the pressure head. Kapitza found a velocity proportional to the square root of the pressure head, and interpreted this as evidence that the flow was turbulent. He gave a value of 10^{-3} c.g.s. units as an upper limit to the viscosity of helium II. Giauque in California has also observed the flow of helium II through an annular tube and has obtained a temperature variation of viscosity of from 10^{-4} to 10^{-3} c.g.s. units. Allen and Misener endeavoured to reduce the velocity of flow by using finer capillaries to obtain more nearly the condition for stream-line flow, and found that the rate of flow varied as a power of the pressure head of even less than one half. It was found that the dependence of velocity on the pressure head decreased with decreasing capillary size. For glass capillaries of 0·0015 cm. radius, it was found that the velocity varied as the 1/6 power of the pressure, whilst for capillaries of 5×10^{-5} cm. in radius, obtained by packing a metal tube with parallel wires and then drawing the tube through dies, the velocity became absolutely independent of the driving pressure. In the latter case, the velocity increased very rapidly with decreasing temperature and reached a value of 20 cm. per second at 1·1° K. The flow also appears to be non-classical in the case of the variation of length of the capillary, since a variation of length by a factor of 70 produced only a fourfold change in the velocity.

On the other hand, experiments made by Burton in Toronto showed that with relatively wide and short tubes and rapid flow, the velocity is linearly proportional to the pressure head, and that the viscosity so determined agrees with the value obtained by the damping of oscillating disks. The anomalous features appear, therefore, when the flow takes place through very long and fine capillaries (radii less than 10^{-3} cm.).

*Actually Kapitza used the essentially similar method of radial flow between two parallel plates with small separation.

A little light is thrown on these curious results by the experiments of Mendelssohn and Daunt on the creep of liquid helium II in the form of mobile films over solid surfaces. If an open vessel be partially immersed in liquid helium II, it was observed that liquid gradually collected in the vessel until the liquid levels in vessel and bath were coincident. The rate of filling increased rapidly with lowering temperature. The mechanism was found to consist not in evaporation and recondensation, but in the transfer of liquid by means of surface films. At all temperatures in helium II the rate of transfer of liquid by means of the surface films was found to be independent of the difference in level. Both the thickness and the velocity of propagation of a film have been measured. The thickness is of order 5×10^{-6} cm. and the velocity increases from zero at the λ-point to 20 cm. per second at 1° K., which gives a rate of transfer of about 10^{-4} cubic centimetres per second per centimetre width of film. If films are formed above the λ-point, that is, by helium I, they are not more than 10^{-7} cm. thick.

A rough synthesis of the experimental results on flow of helium II can be attempted as follows. In flow through a tube, two distinct but by no means separate processes are taking place*: (*a*) the normal flow of a fluid with a viscosity (of order 10^{-4} c.g.s. units) which increases with decreasing temperature, and (*b*) creep along the inside walls of the tube by means of a surface film (of thickness of the order of 5×10^{-6} cm.), the velocity of which increases rapidly with decreasing temperature. For wide tubes, effect (*a*) predominates and the flow approximates to that of a normal viscous fluid. As the size of the capillary decreases, effect (*b*) becomes more pronounced, whilst for capillaries less than 10^{-4} cm. in radius, effect (*a*) becomes negligible and the quantity of liquid flowing per second is directly proportional to the circumference of the capillary.

Heat Conduction. The first experiments in the transport of heat through liquid helium II were made by Rollin and Keesom; their observations showed that helium II was a most efficient agent for the transport of heat, being far more effective than copper at the same temperature. It was observed later by Allen, Peierls and Uddin, and shown more convincingly by Keesom and Saris, that the rate of heat transport was not proportional to the temperature gradient. It is thus impossible to measure a true thermal conductivity for the liquid. The rate of heat transport is greater the smaller the gradient, and reaches a value corresponding to a conductivity several thousand times as great as that of copper at room temperature with gradients of the order of 10^{-6} of a degree per cm. For a given gradient the 'conductivity' increases rapidly below the λ-point to a maximum at 2·0° K. and then falls again. Simon and Pickard of Oxford have found that the anomalously high conductivity disappears at the temperature at which the specific heat becomes normal.

Fountain Effect. The fountain effect, which was discovered in the Mond Laboratory, shows in the most striking manner the fundamental difference between helium II and any other known liquid. In its simplest form, the effect may be described as follows. A tube is partly immersed in helium II; the lower end of the tube is a capillary; both ends are open and an arrangement is made to heat the liquid in the upper part. A steady flow of heat is thereby maintained down the capillary. Under these conditions, it is observed that the liquid inside the tube rises above the level outside, showing the existence of a pressure in the reverse direction to the heat flow. A more spectacular demonstration can be given by placing powder in the lower half of the immersed tube through which the heat flows. To produce the heat current in this case, it is sufficient to shine light on the powder. With this arrangement the liquid may be made to rise right out of the tube, and in fact a steady 'fountain' several centimetres in height can easily be produced.

Quantitative measurements on the magnitude of the reaction pressure are very incomplete. Some data, however, are available from measurements* on the reaction to heat flowing in helium II through a tube filled with powder particles. The reaction pressure was found to attain a maximum value of approximately half an atmosphere for a gradient of 1° per cm. at 1·7° K. The value of the heat conductivity through the powder-filled tube was lower by a factor of a hundred than that through a smooth capillary of the same open cross-section. It seems, therefore, that the very large conductivity observed for helium II when the heat flows through smooth tubes is caused by violent convection currents which are set up by the reaction mechanism. This might be the reason for the apparent variation of conductivity with temperature gradient.

A complete understanding of the fountain effect must naturally await a satisfactory theory of the constitution of liquid helium II. However, a few interesting deductions can be made. In the first place, in the simple arrangement described above, the force holding the liquid above the bath level can only come from some form of interaction of the liquid with the walls of the tube or the attached heating wire. No other support is available, and the vapour pressure above the bath and inside the tube are sensibly the same. Secondly, this

*To be published shortly by J. F. Allen and A. D. Misener.

**Proc. Cam. Phil. Soc.* (in the Press).

interaction must result in a downward thrust on the tube equal to the weight of liquid above the bath level. From the atomic point of view, this means that the interacting atoms are steadily transferring momentum in a downward direction to the tube, just as the thrust on the walls of a vessel containing gas implies that the atoms steadily lose momentum to the walls as they are reflected. This has the interesting consequence that the main heat transport in helium II at these temperatures (below 2·19° K.) cannot be due to the propagation of elastic waves as in ordinary liquids and solids, since elastic waves do not carry momentum.

Many and varied hypotheses have been made concerning the constitution of helium II. Michels, Bijl and de Boer and the present authors independently suggested that certain atoms which have more than the average energy in helium II have, as well, a larger than average mean free path inside the liquid, and that heat flow represents a drift of these moving or 'excited' atoms. Later, this idea of energetic particles moving through the unexcited or 'condensed' atoms was developed by Tisza to include a theory of flow. This theory has not yet reached a quantitative stage, but has proved interesting and suggestive.

Note added in proof: Since this article was written, F. London has published (*Phys. Rev.*, 54, 947; 1938) an enlargement of the theory which he based on the consideration that helium at low temperatures exhibited Bose-Einstein condensation phenomena. His theoretical interpretation of the behaviour of liquid helium II appears to be quite in accordance with the experimental deductions given above, particularly with regard to the properties of flow of both heat and liquid.

The Earthquake in Chile

THE recent earthquake in Chile (NATURE, Feb. 4, p. 197) may justly be regarded as one of the greatest of such catastrophes in that country, and also in the world. According to local reports by survivors, the shock started about 11.35 p.m. local time on the night of January 24, and during the two or three minutes which it lasted ruined four towns and several villages, whilst doing severe damage to several others. The earthquake was felt from Valparaiso in the north to Puerto Montt in the south, the area affected now being estimated at 300,000 square miles. Large-scale damage was done from Talca in the north to Valdivia in the south, the area chiefly concerned being the province of Nuble, and the damage to property is estimated at £1,500,000. Altogether approximately 30,000 people were killed, 50,000 injured and there are about 100,000 homeless refugees.

At Chillan, a town of 45,000 inhabitants forty miles east of Concepcion, in the neighbourhood of the epicentre, two walls of the massive cathedral, the post office and telegraph building, the O'Higgins Infantry Barracks and most of the houses collapsed immediately. A theatre and a kinema collapsed, killing all the people inside. The hospital, although badly cracked, was one of the three or four buildings left standing after the initial shocks; but owing to the number of casualties the supply of anæsthetics ran out and the surgeons were obliged to operate without. Immediately after the shock the supply of electric power and water ceased, so that the surviving firemen with the one remaining engine were powerless against the fires which followed. Moreover, transport was impossible on the railway and difficult on the roads around. After rescue operations, the Government ordered the evacuation of the town, it being estimated that here 10,000 lost their lives.

Parral, San Carlos and Egun, within the isoseismal 10, were also razed and evacuated. The villages of Retiro, Copihue, Zongavi, Bulnes and Quirihue were completely demolished. Andotros was very severely damaged, San Rosendo had 2,000 dead, and at Cauquennes, the town celebrated for its mineral springs, half the property including the hospital and prison was destroyed, killing 4,000 and injuring 800. At Concepcion, the fourth largest city in Chile, situated near the mouth of the Bio-Bio River and having a population of 89,000, three fifths of the city is in ruins and there are 2,000 dead. Many famous buildings, including the Teatro Campo Club and hospital, were destroyed. Here also a kinema collapsed killing 300 people inside it at the time, and fires added to the destruction in the city. It is expected that some of the fine modern buildings such as the Banco Central, the University and the Plaza Hotel which have been built to withstand earthquake shocks will have survived, unlike on the fifth occasion when Concepcion was completely destroyed on February 20, 1835. The damage was severe, but not so great at Los Angeles, Longavi and Linares. At Talcahuano, the port

and naval base, 19 are reported dead and 100 injured, fires adding to the destruction caused by the shock. At Talca many buildings were injured and the prison collapsed killing 10 convicts and injuring 20 others. Farther away, at Valparaiso, the church spire was damaged and at Santiago, 250 miles north of Concepcion, the earthquake was strong enough to cause cracks in buildings.

Faulting has been on a considerable scale, and in the Province of Nuble the fissures caused by the earthquake are several kilometres long and often five metres deep.

So far as instrumental evidence is concerned, the shock was world shaking. At Santiago the shock was felt about 11.35 p.m. local time on January 24 (Jan. 25, 3h. 35m. G.C.T.). From Fordham, New York, the shock was reported double with an interval of 10 minutes between the shocks and the needle swung approximately eight inches for both shocks at maximum. It was recorded by instruments in Great Britain, and at Stuttgart in Germany the registration was complete, including eP at January 25, 3h. 46m. 51s., ePP 51m. 45s., $SKKS$ 58m. 25s. and LQ at 4h. 25m. with $T = 50$–55 sec. all in G.C.T. At Hamburg one eP' was registered at 3h. 47m. 8s. and another at 50m. 49s., both on the vertical seismograph, e_zPP at 51m. 44s., eL_{EN} at 4h. 20m. and eL_z at 4h. 24m. all in G.C.T. together with other pulses. Taking into consideration all the above evidence, it appears that the epicentre was near lat. 36° 45′ S. and long. 72° 15′ W., probably correct within 10 minutes of arc, that the depth of focus was normal and that for the first shock the origin time was January 25 at 3h. 32.0m. G.C.T.

Since the first shock, aftershocks have been frequent and often of considerable severity. The frequency and intensity has as usual in general diminished, though there have been notable exceptions. There were severe disturbances on the night of January 27 and on January 28. On January 30, at 3h. 45m. G.C.T. a severe shock with the same epicentre occurred and completely demolished the three or four remaining buildings and walls at Chillan.

Sympathetic occurrences in the Andes probably due to the disturbance of the Chilean shock or resulting from the same deep initial cause are reported, including further earthquakes and tremors, and on January 29, the Mt. Lliama volcano was in eruption.

MAP SHOWING ISOSEISMAL LINES AS AT PRESENT KNOWN. + = APPROXIMATE EPICENTRE

Further news of the catastrophe is expected in reports of the Chilean seismologists and geologists who left Santiago for the epicentral region immediately after the shock.

Obituary Notices

Prof. H. H. Woollard, F.R.S.

THE very sudden death of Prof. H. H. Woollard on June 18, at the age of forty-nine years, is a tragic loss for the science of anatomy in Great Britain.

Woollard was a product of the University of Melbourne, where he took his medical degree in 1910. During the Great War he saw active service with the Australian Army Medical Service and attained the rank of Lieut.-Colonel. After the War he intended to work for the fellowship of the Royal College of Surgeons, and to this end went to University College, London. Here he came under the inspiring influence of the late Sir Grafton Elliot Smith, an influence which led him completely to change his original plans; for he now decided to take up the study of anatomy as a scientific career. He was appointed to the staff of the Department of Anatomy at University College, where he worked until 1928. He was afterwards appointed to the chair of anatomy and histology in the University of Adelaide, to the chair of anatomy at St. Bartholomew's Hospital Medical School, London, and finally as successor to his distinguished teacher Elliot Smith, in University College, London, in 1936.

Woollard's contributions to anatomy, direct and indirect, were outstanding. His early papers were mainly morphological in character, and of these may be mentioned an important and comprehensive

monograph on the anatomy of *Tarsius*, and comparative studies on the cerebral cortex of *Tarsius*, the brain of *Orycteropus*, and the retina of primates. He was, however, essentially an experimental anatomist, and he received a great stimulus from his contact with American anatomists during the year which he spent at Johns Hopkins University as a Rockefeller research fellow. As a consequence of the experience which he gained from this visit, Woollard published the results of several important experimental studies; for example, the development of the vascular patterns of the limbs as demonstrated by the micro-injection of living embryos, the phagocytic activity of hæmal glands, and the vital staining of the leptomeninges. Probably some of his best work was that dealing with the innervation of the heart and blood vessels, which was completed in 1925 and 1926. In 1927 he published his "Recent Advances in Anatomy" which attracted vigorous attention to the development of experimental anatomy in other countries, and did much to stir his contemporary colleagues to work for the revivification and reorientation of anatomical teaching and research in Great Britain.

During his brief tenure of office in the University of Adelaide, Woollard made full use of his opportunities by his detailed and original studies of the Australian brain and of the distribution of blood-groups among the native populations. On his return to England, he concentrated his research activities on the peripheral nervous system. He had acquired extraordinary skill with the difficult technique of vital staining with methylene blue, and he applied this technique to very good effect in his experimental studies of peripheral innervation. Mention has already been made of his work on the innervation of the heart and blood-vessels. This is work to which continual reference is made by those who are concerned with the neural control of the cardio-vascular system. He applied the same technical methods to problems of cutaneous innervation, and for this purpose he used himself as an experimental subject. He aimed at correlating the localization of different sensory spots in his own skin with different morphological types of nerve ending, a study which involved a considerable amount of discomfort in the small operations which he permitted to be carried out on himself in order to obtain material for histological examination. The results of some of these observations were published during 1936 and 1937, and in 1938 he was elected a fellow of the Royal Society.

Woollard died in the middle of a scientific career when he had already achieved much, but his research activities were so productive that his colleagues confidently looked forward to a great deal more from him and from those whose work he was directing in his department. More than this, he aspired to raise the science of anatomy to a level of achievement and activity which he regarded as its proper status. His energetic example had inspired many of his fellow anatomists to work with him to this end, and the first fruits of these efforts were already becoming evident. Hence, his death will be felt as an extremely serious loss for the subject which he represented.

His friends mourn a devoted worker who spared himself not at all in his scientific and departmental duties, a colleague who was always ready to give help and advice in all manner of difficulties, and a man who had a very lovable character.

W. E. LE GROS CLARK.

Mr. A. B. MacDowall

WE regret to record the death, which occurred on January 10, of Alexander Baird MacDowall, who was a frequent contributor to NATURE a generation ago.

Mr. MacDowall was born at Alloa on December 18, 1843. At fifteen years of age he was sent to the Old College in High Street, Glasgow, long since swept away, where he came into contact with Prof. W. Thomson, afterwards Lord Kelvin. Next he went to Berlin, returning after six months to take his degree at Glasgow. This was followed by a trip to Melbourne in a sailing vessel for reasons of health, the return journey being made via Cape Horn.

On his return to Great Britain, Mr. MacDowall settled in London and started upon a career of general journalism, working in the British Museum and at the Patent Office. There he met Sir William Harcourt, Thomas Carlyle and others, including D. E. Hughes, inventor of the microphone. He followed closely the development of the telephone, and long before it was in general use, he had an experimental installation set up in his house.

About this time, Mr. MacDowall was contributing to NATURE, and also to the Royal Meteorological Society, on the subject of terrestrial and solar meteorology and the relationship between them. In 1895 he brought out a small book "Weather and Disease: a Curve History of their Variations"; the mode of representation adopted was that commonly used at the time to illustrate the relation between two variables, namely, the production of smoothed curves recording the averages of five or ten consecutive values. A similar method was used in a paper on the relation of terrestrial weather statistics to the sunspot cycle presented to the Royal Meteorological Society in 1897.

In recent years, Mr. MacDowall travelled a good deal in the British Isles and on the Continent, settling down some twelve years ago at Rothesay in the Isle of Bute. He retained to the end his lively interest in scientific developments. His wife, Emily, a daughter of William Liddon and Emily Howard, died in 1935.

WE regret to announce the following deaths:

Paul Séjourné, free academician of the Paris Academy of Sciences, who was known for his work on the design and structure of bridges, aged eighty-seven years.

Prof. Josef Šimon, professor of roentgenology and radiology in the Masaryk University, Brno, aged forty-one years.

News and Views

A New Type of Nuclear Reaction

ON p. 251 of this issue of NATURE, an account is given of recent investigations by Prof. O. Hahn, Prof. L. Meitner and F. Strassmann on the bombardment of uranium by neutrons. Prof. Meitner and Dr. O. R. Frisch have discussed the development and implications of these results in a letter which also appears in this issue (p. 239). Experimental confirmation of these conclusions, it is claimed, is announced in the following cable, dated February 3, received from R. D. Fowler and R. W. Dodson, of the Chemical Laboratory, Johns Hopkins University. "We have bombarded uranium nitrate in a three millimetre ionization chamber with deuterium neutrons and found that particles causing a very intense ionization, at least five times that from natural uranium alpha particles, are produced. Fast neutrons from one milliampere two hundred and fifty kilovolt deuterons produced thirty-five particles per minute. Placing paraffin around ionization chamber increases this to seventy counts per minute. We believe this to be confirmation of work of Hahn and Strassmann (*Naturwissenschaften*, Jan. 6; Frisch and Meitner NATURE [Feb. 11, p. 239—Editor]) in which activity ascribed to barium was found after neutron bombardment, and that these particles are barium ions of about one hundred million volts energy.

"We have also bombarded thorium oxide in similar ionization chamber, with deuterium neutrons. Fast neutrons in same intensity as above produce thirty intensely ionizing particles per minute. Paraffin does not increase the effect. We believe thorium is also disintegrated by fast neutrons into fragments of about one half thorium mass, having energies of about one hundred million volts."

Dr. W. D. Coolidge

THE Faraday Medal of the Institution of Electrical Engineers given annually "either for notable scientific or industrial achievement in Electrical Engineering or for conspicuous service rendered to the advancement of electrical science", has been awarded to Dr. W. D. Coolidge, director of the research laboratories of the General Electric Co., Schenectady. Dr. Coolidge was born in 1873, and educated at the Massachusetts Institute of Technology and at the University of Leipzig, studying especially physical chemistry. After holding certain academic posts, he joined the staff of the General Electric Co. in 1905, was promoted to be associate director in 1928 and in 1932 was appointed director of research. The name of Coolidge is associated with advances in many fields, but perhaps all his later work may be traced back to his important researches into the production of ductile tungsten, which revolutionized the design of electric lamps and had immediate applications in thermionic devices of several types. In the Coolidge X-ray tube, which was developed just before the Great War, the tube was evacuated as thoroughly as possible and the electrons necessary to produce X-rays were emitted by tungsten filaments heated to a suitable temperature. In this tube, for the first time, the X-ray worker was able by simple means to control separately the voltage and current applied to his tube, while the steadiness of running and constancy of X-ray output were much greater than had been possible with the earlier ionic type of tube. Later, Coolidge developed tubes capable of operating at tensions up to a million volts in which the electrons were accelerated in stages. Somewhat similar tubes were made of such a design that the electron beam, instead of being intercepted by a target and producing X-rays, passed through a thin window and gave rise to remarkable fluorescent, chemical and biological effects, the possibilities of which have not yet been completely explored.

Josiah Willard Gibbs (1839-1903)

ON February 11 the centenary occurs of the birth of the distinguished American physicist, Josiah Willard Gibbs. Born at New Haven, he was the son of Josiah Gibbs (1790–1861), professor of sacred literature in Yale Divinity School. He entered Yale College in 1854 and graduated four years later; he continued his studies there until appointed a tutor in 1863. The years 1866–68 he spent in Paris, Berlin and Heidelberg. In 1871, he was appointed to the chair of mathematical physics in Yale College, and this appointment he held until his death, which occurred at New Haven on April 28, 1903. Gibbs' first contributions to mathematical physics were two papers on thermodynamical problems published in 1873. These papers were followed by his memoirs "On the Equilibrium of Heterogeneous Substances" published in two parts in 1876 and 1878. This was translated into German by Ostwald and into French by H. le Chatelier. He also investigated certain problems in connexion with the electromagnetic theory of light and other subjects. He was a foreign member of the Royal Society, and in 1901 received the Copley Medal. He was also a corresponding member of the Paris Academy of Sciences. At the anniversary meeting of the Royal Society when the award was announced, Sir William Huggins, the president, said that Gibbs "was the first to apply the sacred law of thermodynamics to the discussion of the relation between chemical, electrical and thermal energy and the capacity for external work. To chemistry his most important result is the so-called phase rule, the law which governs the general case of complete heterogeneous equilibrium and which is applicable to chemical change generally".

Refugee Settlement in British Guiana

THE United States has offered to send an expert Commission to investigate the possibilities of refugee settlement in British Guiana, and the offer has been

accepted by the British Government, who have appointed additional members to the Commission. The terms of reference of the Commission are: To study and report upon the suitability and practicability of large-scale colonization in British Guiana for involuntary emigrants of European origin, from the physical, climatic and economic points of view; to estimate the approximate numbers that might be settled there (*a*) immediately, (*b*) over a term of years; to calculate the probable cost of such settlement: if mass colonization appears feasible, to recommend a general plan of settlement. The names of the members are: Dr. Edward C. Ernst, assistant director, Pan-American Sanitary Bureau (chairman); Colonel Howard U. Nicholas, United States Army Engineering Corps, Panama Canal; Dr. Joseph A. Rosen, Jewish colonization expert and agronomist; Mr. Emile C. Bataille, colonization expert with Canadian experience; Dr. Anthony Donovan, sanitary engineer; Mr. Desmond Holdridge, who has previous experience of the Colony (secretary). Sir Crawford Douglas-Jones, formerly Colonial Secretary of British Guiana; Sir Geoffrey Evans, formerly principal of the Imperial College of Tropical Agriculture, Trinidad, now economic botanist at the Royal Botanic Gardens, Kew. Dr. D. W. Duthie, agricultural chemist to the British Guiana Government, is being attached to the Commission for the purpose of advising and co-operating with the Commission.

Science and World Resources

THE December issue of *Fact* (No. 21. 6*d*.) contains a study "Science and World Resources" by Richard Palmer, which gives a comprehensive but readable survey of the way in which the world economy is changing under the impact of scientific advance. Mr. Palmer gives a dynamic picture of the way in which scientific discoveries and their technical development from synthetic dyes such as indigo and alizarin to synthetic rubber, the new textile fibres such as rayon and more recently 'Lanital' and 'Nylon' and the numerous synthetic resins or plastics, are influencing not merely the development of new industries or the displacement of old industries but also the distribution and availability of materials in the world, the location of industry, etc. Mr. Palmer's survey ranges over the whole field of materials, including beet sugar, alcohol, petroleum, coal, fertilizers, and light metals, and indicates admirably even to the non-technical reader the new freedom which the organic chemist is giving us and some of the possibilities if the new powers and opportunities are wisely used. Other chapters range over the possibilities in the way of power production which we owe to science and their significance in world economy, as well as the possibilities in agriculture and the way in which science has made it possible to improve working conditions and thus both industrial efficiency and the climatic or geographical zones within which effective production by human beings is possible. The essay provides an excellent background against which to discuss such current problems as those of raw materials and their bearing on the colonial question, the limits of self-sufficiency policies, sanctions, economic nationalism and the like. The realistic picture he gives enforces the necessity for strengthening, while there is yet time, our efforts to create a social and international order in which knowledge will be used to the full in the service of all mankind.

The Empire Service Broadcasting Station

Mr. L. W. Hayes and Mr. R. N. MacLarty presented an interesting paper to the Institution of Electrical Engineers on February 2. They first gave an account of how broadcast transmissions with short waves initially started at the Chelmsford works of Marconi's Wireless Telegraphic Co. in 1927. This gave intelligible reception at practically every place on the earth's surface at almost every period of the day and year. A serious difficulty that had to be overcome was due to the wide difference in longitude of the different Dominions and Colonies of the British Empire. For this reason, a transmission sent out at a given time in England would arrive at very various local times of the night and day in the different Dominions. Broadly, the aim of the service is to give listeners anywhere in the Empire a daily programme of about two hours' duration; the installation of the new broadcasting service started in 1933 practically does this. Earlier than this, reports received in the West Indies also gave a service at the same time in Western Australia, and the announcement of "London calling the African and West African Zones" was being heard simultaneously at night in Africa, in the early evening in South America and the West Indies, and at breakfast time in New Zealand. This showed that dividing the earth into geographical zones could cause confusion. Accordingly, the daily transmission from the Empire Station at Daventry was divided into five sessions: Transmission No. 1, Transmission No. 2, etc., in accordance with a time schedule, the programme from the first zone being recorded and then transmitted at the most suitable times to the other zones. In 1935, a sixth transmission was added, primarily intended for evening listening in western Canada, but serving also North America generally and giving an early morning service to India.

Conditions of Engineering Contracts

THE subject-matter of an engineering contract necessitates that the documents of which the contract is composed must make provision for contingencies and events of a special nature. In this respect, it has peculiarities not to be found in other forms of contract, and is often inevitably of considerable length. The Council of the Institution of Civil Engineers asked Mr. E. J. Rimmer to write a paper on the subject which will be discussed by correspondence until May 15. The Council gave the author of this paper a very wide discretion in the choice of the title and in the scope of the paper. He has wisely chosen to give a comprehensive survey of the whole subject of engineering contracts. Many engineering contract works are to be constructed in, or erected and fixed on to, land. They cannot, therefore, be rejected and sent back to the contractor

if they prove to be unsatisfactory; the material and labour may have to be carried out in the open air with material and labour of varying quality; the conditions of excavation and foundation cannot be entirely foreseen until the ground is opened up; the execution of the works also may result in damage to property belonging to other persons. In addition, the completion of the work may extend over several years, and the employer may desire to use the completed parts of the work before the final completion of the whole.

IT was formerly the custom to prohibit assignment and to allow subletting only when the previous permission of the engineer had been obtained. Recently it has become fairly common to provide a form to be attached to and filled up with the tender, upon which the contractor declares the names of the firms to which he desires to sub-let portions of the works, and if these firms are approved before the contract is sealed the contractor may straightway sublet work to these firms. The retention in the hands of the engineer of supreme power as sole arbitrator has, considering the terms and circumstances of present-day contracts, become rather an anachronism. Old forms change slowly and some of the reforms suggested are not quite satisfactory. In Mr. Rimmer's opinion, some phrases and clauses now accepted as standard practice are confusing and ambiguous. The basic conditions upon which standard conditions should be framed must first be decided by the parties concerned. If the persons have different views, they are sometimes determined on the basis of compromise. But if the conditions are to be clear and unambiguous, there is no room for compromise on the manner and phraseology on which these principles are to be stated.

Changing the Face of London

IN his Friday evening discourse at the Royal Institution delivered on February 3, Sir Charles Bressey dealt with the question of "Bigger London or Better London?" He illustrated by lantern slides the growth of Greater London since the Great Fire and described the complex administration of the area, now that its population has reached 9¼ millions, equivalent to the entire population of Norway and Sweden. In twelve years time the population within a thirty-mile radius of Charing Cross may reach a 'peak' figure of 10¾ millions. Meanwhile growth continues with such alarming rapidity that the inadequacy of British road communications has necessitated the preparation of the Highway Development Survey published by the Minister of Transport last May. Its recommendations, looking thirty years ahead, include the construction of about 123 miles of new routes in the L.C.C. area, 368 miles outside the L.C.C. area (exclusive of motorways) and motorways to a total length of 307 miles. The total cost will lie between £160,000,000 and £230,000,000. Sir Charles stressed the urgent need for a new east-west route across London (the east-west connexion), for the completion of the South Circular Road, the formation of a loopway around the City, and the extension of the Thames Embankment so as to form a continuous riverside promenade extending for eight miles from Putney Bridge to the Tower of London. The incessant congestion of London's main roads in time of peace was some inkling of what might happen if a hurried evacuation had to be undertaken. If the Government decides that the present time is not propitious for the undertaking of extensive works of road construction, nothing can justify the postponement of measures for safeguarding the course of new routes, which include tunnels adapted for use as part of London's air-raid defence schemes.

Sir Arthur Evans: Gifts to the Ashmolean Museum

SIR ARTHUR EVANS has presented to the Ashmolean Museum, Oxford, of which he was keeper for a period of twenty-five years ending in 1908, his unique collection of Minoan sealstones and gems, gold rings and jewels, as an accession to the recently rearranged 'Minoan Room'. The collection, as is recalled by the Oxford correspondent of *The Times* of February 2, is "far-famed and unrivalled", embracing every period and class of the Minoan gem-cutter's art—prisms, button-seals, cylinders and ring bezels in steatite, cornelian, ivory and other materials, engraved with pictographs, scenes of ritual, bull-fighting and other sports. Among the rings is the famous great gold ring of Nestor, the group of gold beads known as the Treasure of Thisbe, all engraved with scenes of ritual, combat and ancient legend. Since Sir Arthur began his archæological explorations in Crete in the early nineties of the last century, both while he was keeper of the Museum and after, he has been liberal in contributing to its collections examples of the objects discovered by him in his excavations. With this latest gift, the Ashmolean collection of Minoan antiquities becomes the most important and the most complete outside Crete itself. Recent alterations of the Museum, in which the largest archæological gallery has been divided into three sections, have made it possible for Sir Arthur, with the assistance of Miss Mercy Money-Coutts, to make a new installation of Cretan antiquities, in which the older collections have been supplemented by groups of casts, numerous photographs, diagrams and water-colour drawings, with figurines, smaller antiquities and pottery which he has transferred to the Museum from his private cabinets. His benefactions have not, however, been confined to the donation of antiquities from Crete. They include classical antiquities, large series of Greek, Roman and Anglo-Saxon coins, and other objects, as well as the great collections of stone and bronze implements, Anglo-Saxon jewellery and other material which belonged to his father, the late Sir John Evans.

Morbid Heredity in Isolated Communities

AN interesting study of morbid heredity in man in an isolated community by Dr. J. W. McFeeters, for which the Sir Charles Hastings Clinical Prize for 1937 has been awarded (*Brit. Med. J.*, Feb. 4, p. 218), is made the basis of a suggestion that in view of the facilities for tracing family pedigrees in small isolated communities and the inbreeding imposed upon such

communities for generations, similar studies should be undertaken, distributed as widely as possible over the country, before improved communications break down this isolation. The present observations appear to bear out the author's contention that such a series of records is bound to throw light on the occurrence of rare recessive characters, which are much less likely to occur when random mating is the rule rather than the exception. The village here under study consisted of about fifteen hundred inhabitants. Observations of numerous morbid data extended over a period of years, and led to the conclusion that heredity plays an even more important part in many varied conditions than is generally recognized. Of the many conditions studied, eight were chosen for discussion—hereditary cerebellar ataxia, progressive muscular dystrophy, the lymphatic diathesis, otitis media, hernia, cancer of the bowel, rodent ulcer and hydramnios. Among the more significant points which emerge, it is noted that in progressive muscular dystrophy, the condition is definitely sex-linked. It is transmitted by apparently healthy females in three generations. In three cases it was associated with failure to bleed, a peculiarity not previously recorded in this connexion. The incidence of hernia is curiously restricted. Out of twenty cases, fifteen occurred in two families; and heredity evidently played a part even more important than strain. The possibility of the occurrence of a zygotic lethal factor in the male—a possibility suggested with some doubt by Ruggles Gates—receives support from the study of hydramnios, where there may be a relationship of the cases on the paternal, and not the maternal side.

Natural and Synthetic Fibres: Sisal and Flax

INTERESTING information on the development of natural and synthetic fibre industries is published in the *Journal of the Royal Society of Arts* (**87**, No. 4494). Discussing sisal and flax production in East Africa, Dr. W. H. Gibson maintains that the sisal industry is now well established in Kenya, binder twine and string being at present the chief uses for the fibre. Sisal is also finding a ready market for matting and upholstery filling, and tests regarding rope manufacture are giving satisfactory results. The flax industry in Kenya, on the other hand, has so far been less successful, due largely to the difficulties encountered in the process of retting, that is, the preliminary steeping process during which the fibres are loosened from the woody stem. Experiments recently carried out in the United Kingdom, however, have shown that it is possible to eliminate this process and extract the fibre from the natural flax, and with this discovery the way for the development of the industry in Kenya and other suitable parts of the Empire seems most promising.

THE modern counterpart of these vegetable fibres, namely, the synthetic textiles, are the subject of a paper by Dr. E. F. Armstrong. Artificial silk produced from wood pulp and its more recent development, staple fibre, are well-known supplements to, and competitors with, natural silk, wool and cotton. A new textile called 'Nylon' has, however, recently been produced by the du Pont Laboratories in the United States. This thread is of an entirely different origin to rayon, as it is a plastic substance derived ultimately from coal tar, with dyeing properties akin to natural silk or wool, and it appears to have a most promising future. Two other types of fibre may be mentioned. The first is 'Lanital', an Italian product made from casein and used as a wool substitute, but as it lacks wet strength, attempts are being made to produce a better product from the protein of the soya bean. The second is spun glass which, though unsuitable for clothing, is used for electrical insulation, gas and liquid filtration and decorative purposes. In spite of the popularity of synthetic textiles, it is noteworthy that in 1937 the world production of these fibres was only in the ratio of 1·8 to 28 of natural spinning materials.

Forestry in Finland in 1937

THE annual report of forestry activities in Finland (XVII Metsätilasto Forststatistik—Kertomus Metsähallinnon Toiminnasta 5, 1937. Berättelse över Forstförvaltningens Verksamhet, Ar 1937), published in Helsinki last year, sums up the work of this progressive Forest Department. The great advance made by Finland since the Great War and the position she has taken in European forestry circles may to some extent be attributed to the fact that the Forest Department had a large forest capital at its back already under exploitation. Consequently a variety of problems were presented to the trained forester, from forestry education through sylvicultural management and protection down to the study of utilization, the improvements possible in extraction, statistics and prices, and so forth. The forestry reforms of 1921–23 prescribed the division of the country into four districts containing ten forest inspections and ninety cantonments (subdivisions of an inspection). Each district was administered by a local forestry bureau, under whom were the inspections, each in charge of an inspector. An important outcome of a decree of July 1934 is the gradual replacement of the untrained forest guards by *chefs de travail* or overseers, all of whom will have received training at one of the forestry schools, of which there are six. Considerable progress has been made with working plans and maps required in connexion with their preparation—revision of these plans is undertaken every ten years. The report deals in detail with the commercial activities, since the forests play so important a part in Finnish economy, and the British market is a very valuable one. An interesting point in the report is the policy undertaken by Government of settling a proportion of the population within the large forest areas owned by the State.

The Phenological Survey

THE new phenological forms distributed by the Royal Meteorological Society to its six-hundred-odd observers for 1939 have a further reconstruction of selected specimens of fauna and flora on a much more scientific basis. A noticeable feature is a considerable increase in the number of Lepidoptera selected for special observation, there being fifty selected

indigenous Lepidoptera the appearance of which is to be recorded, and three immigrants. This has been at the expense of a considerable reduction in the bird migration list, as many of those subjects had been reported on continuously for many years. There has been an extension in the selected observations on trees, chiefly in regard to leafing times. The modern system of Latin bird names is now used, although observers are warned that the old system is still used in some reference books. Particular stress is laid on the importance of recording the effects of abnormal weather upon the vegetation, etc. Spring and early summer appearance dates of the peacock and red admiral butterflies should help gather additional information regarding the question of their hibernation. A valuable addition to the recording of flowering of plants and leafing of trees is the recording, as well as the date, of the sheltered or open position of the plant. On the whole, the amount of observation called for has been considerably increased, but individual phenologists are encouraged to send in returns of any one group if they wish.

Norman Lockyer Observatory

Bulletin No. 2 of the Norman Lockyer Observatory, Sidmouth, recently issued, contains an appreciation of the late Sir Robert Mond, chairman of the Observatory Corporation for twenty-one years and a generous benefactor to the Observatory. A further note of a personal nature gives an account of the unveiling of the memorial to the late director, Dr. W. J. S. Lockyer, at which Sir Robert Mond presided just three months before his death. Part of the memorial alluded to is the Oxford microphotometer, a description of which is given in the present *Bulletin* by the director, Mr. D. L. Edwards, together with illustrations of representative tracings of stellar spectra and of several line-contours, obtained with the instrument. Mr. D. R. Barber contributes two papers. The first is a detailed account of the magnificent auroral display of January 25, 1938, which appears to have been visible over practically the whole of Europe and the North American continent. The second paper deals with the objective prism-spectra of Finsler's Comet obtained at its apparition of 1937. In a preliminary investigation (N.L.O. *Bull.*, No. 1), Barber had found that a visual comparison of the intensities of the cometary bands at 4700 and 3880 A. due to C(*IV*) and CN(*IV*) radiation respectively indicated that the former was about $2\frac{1}{2}$ times stronger than the latter, a result in the opposite direction from that deduced from slit spectrograms secured at the Mt. Wilson and the Lick Observatories. The Sidmouth spectrograms have now been analysed by means of the new microphotometer, and Barker confirms his first result with, however, a reduction of the ratio of relative intensities from $2\frac{1}{2} : 1$ to $1\frac{1}{4} : 1$.

Literature for Adult Education

AN important factor in the success of discussion groups or public lectures as a means of education for citizenship is the provision of books and other suitable material for reading. A pamphlet, "Printed Page and the Public Platform", which has recently been issued by the Office of Education, United States Department of the Interior (Washington, D.C.: Gov. Printing Office, 20 cents), analyses the different factors involved and gives an account of experiments and experience in the United States which should be highly useful to those interested in adult education in Great Britain. The necessity for close co-operation between libraries and such discussion groups is emphasized, and a number of practical suggestions are detailed to facilitate co-operation. The scope and functions of reading lists are critically discussed and the importance of having the reading material as accessible as possible to those taking part in the discussions or attending lectures is recognized. Equally important is the suitability of the material, and while the criticism is not specifically directed at scientific literature, it applies equally to that intended for the general public. Able exposition is a first condition of success, involving an understanding not only of the subject handled but also of the readers to whom the book or article is addressed, and if pamphlet literature admittedly presents special difficulties, the problem is one which deserves greater attention because of its greater appeal to many readers in spite of the distribution difficulty.

The International Seismological Summary

THE I.S.S., compiled at Oxford, is a work which increases in volume and range as it progresses. The volume for January, February and March 1933, which commences the sixteenth volume, has just appeared, and deals with 165 epicentres, 67 being new and 98 repetitions from old epicentres. Nine of the earthquakes mentioned have foci which are below normal. The epicentres have, in general, been determined from observations of *P* alone, instead of by the old method of using *S*—*P* differences. This is said to make very little difference in the case of well-observed earthquakes, but is greatly to be preferred on theoretical grounds. During the last five years, the range of numbers of earthquakes with determinable epicentres recorded in the I.S.S. has been from 569 in 1932 to 653 in 1930. It appears, therefore, that notwithstanding the greater number of stations sending readings, and the greatly improved registration, the numbers of such earthquakes have reached a probable limit. In this volume, stations which send additional readings to the usual *P*, *S*, *L* and *M* are thanked especially, and for the future all are requested to classify wherever possible their *L* readings into *LQ* and *LR*, and to state whether the initial *P* reading is compressional or dilatational.

The *Medical Press and Circular*

THE issue of January 25 of the *Medical Press and Circular* is a centenary double number. This journal is, as the name suggests, the combination of two, namely, the *Dublin Medical Press*, founded in Dublin in 1839, and the *Medical Circular*, founded in London in 1852, the union taking place in 1866. Prof. Rowlette of Dublin contributes a short history of the journal during the hundred years, with biographical

notes on the various editors. Dr. Cecil Wall and Mr. Walter Spencer discuss the progress of medicine and of surgery, respectively, during the period; an illustrated article on "Some Medical Celebrities of the Victorian Age", as depicted in cartoons of *Vanity Fair*, is contributed by Sir St.Clair Thomson, the cartoons being reproduced together with actual portraits; and a chronological list of medical societies and journals in Great Britain and Ireland is furnished by Mr. Reginald West. Other articles and reviews complete a very interesting number.

Art and Psychiatry

UNDER the auspices of the Government Federal Art Project and of the Bellevue Hospital psychiatric department, the Harlem Art Centre in New York City has organized the first exhibition of its kind in the United States, consisting of pictures showing the work of disordered minds. The artists include moronic children, chronic alcoholics, advanced epileptics, manic-depressives and general paralytics. Most of the exhibits indicate mental conflict, being shapeless, lurid and grotesque. The idea underlying the art classes at Bellevue Hospital is to attempt a cure of the mentally sick by encouraging them to express their conflicts and at the same time to give psychiatrists a clearer picture of their patients' emotional life.

Earthquake in Ecuador

SEVERAL earthquakes of sufficient intensity to crack buildings shook a considerable area in Ecuador on the night of February 1, 1939. Altogether nine tremors were felt at Vallechillos and four other towns, and five tremors at Quito. Quito was ruined with the loss of 40,000 lives on February 7, 1797, and simultaneously there was volcanic eruption in Guadeloupe. In the present instance, Cotopaxi, the highest volcano in the world, is in eruption. It was in 1768 and 1877 that previous disastrous eruptions of Cotopaxi took place.

Announcements

THE council of the Institution of Electrical Engineers has elected Sir Archibald Page, chairman of the Central Electricity Board, and a former president of the Institution, to be an honorary member.

M. EMMANUEL DE MARGERIE has been elected a member of the Section of Mineralogy of the Paris Academy of Sciences in succession to the late L. de Launay.

THE Goethe Medal for Art and Science has been awarded by the German Chancellor to Dr. Theodor Kitt, professor of veterinary pathology in the University of Munich.

RESEARCH CORPORATION, of 405 Lexington Avenue, New York, from time to time makes awards to universities for the work of men of science. The Corporation has now made grants to Columbia University, New York, of 2,500 dollars each and Research Corporation plaques, to be made the basis of awards to (1) Dr. H. S. Taylor, of Princeton University, "for his work in the field of catalysis, wherein he has advanced the theory of catalytic action and the art of using catalysts in industrial operations in this field"; (2) Dr. V. Bush, of Massachusetts Institute of Technology, for his work "in the development of powerful and rapid methods of computation and the solution of equations through the invention of automatic apparatus".

ON December 22, the French Minister of Public Health inaugurated the new laboratories of the Pasteur Institute at Garches near Paris where Pasteur made his studies on rabies in 1884.

THE King has commanded that the recently founded British College of Obstetricians and Gynæcologists shall be known as the Royal College of Obstetricians and Gynæcologists.

THE Royal Sanitary Institute will hold its Annual Congress at Scarborough on July 3–8 under the presidency of the Earl of Harewood. Further information can be obtained from the Secretary of the Institute, 90 Buckingham Palace Road, S.W.1.

THE sixth Biennial Congress of the International Hospitals Association will be held at Toronto next September. Further information can be obtained from the Secretaries of the Association, 17 Bloomsbury Square, W.C.1.

THE Mary Putnam Jacobi fellowship of 1000 dollars is offered to a woman graduate of an approved medical school for post-graduate work in the medical sciences. If the appointed fellow is not resident in the United States, she should preferably undertake work there. Applications should be sent to the Secretary of the Fellowship Committee, Dr. Phebe L.-DuBois, 150 East 73rd Street, New York City, before April 1.

THE German Society for Balneology and Climatology will hold its annual meeting at Vienna on March 23–26, when the following subjects, among others, will be discussed: meteorological and physical report; medical report, importance of high mountain climate in treatment of tuberculosis and asthma; physiology of sport in high mountains; drinking wells and artificial salts; natural and artificial mud baths; and artificial climate. Further information can be obtained from Die Reichanstalt für das deutsche Bädewesen, Furstenstrasse 124, Breslau 16.

THE annual mortality from malaria in India averages 2,000,000, an exceedingly high figure even in a population of more than 300,000,000, 30 per cent of whom suffer from the disease. Two thirds of the malaria-stricken in India have no quinine.

ERRATUM.—In NATURE of January 7, p. 23, "A Rapid Visual Test for Vitamin A Deficiency", para. 4, last sentence, for "hæmeralopia" read "hemeralopia".

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 247.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Disintegration of Uranium by Neutrons: a New Type of Nuclear Reaction

ON bombarding uranium with neutrons, Fermi and collaborators[1] found that at least four radioactive substances were produced, to two of which atomic numbers larger than 92 were ascribed. Further investigations[2] demonstrated the existence of at least nine radioactive periods, six of which were assigned to elements beyond uranium, and nuclear isomerism had to be assumed in order to account for their chemical behaviour together with their genetic relations.

In making chemical assignments, it was always assumed that these radioactive bodies had atomic numbers near that of the element bombarded, since only particles with one or two charges were known to be emitted from nuclei. A body, for example, with similar properties to those of osmium was assumed to be eka-osmium ($Z = 94$) rather than osmium ($Z = 76$) or ruthenium ($Z = 44$).

Following up an observation of Curie and Savitch[3], Hahn and Strassmann[4] found that a group of at least three radioactive bodies, formed from uranium under neutron bombardment, were chemically similar to barium and, therefore, presumably isotopic with radium. Further investigation[5], however, showed that it was impossible to separate these bodies from barium (although mesothorium, an isotope of radium, was readily separated in the same experiment), so that Hahn and Strassmann were forced to conclude that *isotopes of barium* ($Z = 56$) *are formed as a consequence of the bombardment of uranium* ($Z = 92$) *with neutrons.*

At first sight, this result seems very hard to understand. The formation of elements much below uranium has been considered before, but was always rejected for physical reasons, so long as the chemical evidence was not entirely clear cut. The emission, within a short time, of a large number of charged particles may be regarded as excluded by the small penetrability of the 'Coulomb barrier', indicated by Gamov's theory of alpha decay.

On the basis, however, of present ideas about the behaviour of heavy nuclei[6], an entirely different and essentially classical picture of these new disintegration processes suggests itself. On account of their close packing and strong energy exchange, the particles in a heavy nucleus would be expected to move in a collective way which has some resemblance to the movement of a liquid drop. If the movement is made sufficiently violent by adding energy, such a drop may divide itself into two smaller drops.

In the discussion of the energies involved in the deformation of nuclei, the concept of surface tension of nuclear matter has been used[7] and its value has been estimated from simple considerations regarding nuclear forces. It must be remembered, however, that the surface tension of a charged droplet is diminished by its charge, and a rough estimate shows that the surface tension of nuclei, decreasing with increasing nuclear charge, may become zero for atomic numbers of the order of 100.

It seems therefore possible that the uranium nucleus has only small stability of form, and may, after neutron capture, divide itself into two nuclei of roughly equal size (the precise ratio of sizes depending on finer structural features and perhaps partly on chance). These two nuclei will repel each other and should gain a total kinetic energy of *c.* 200 Mev., as calculated from nuclear radius and charge. This amount of energy may actually be expected to be available from the difference in packing fraction between uranium and the elements in the middle of the periodic system. The whole 'fission' process can thus be described in an essentially classical way, without having to consider quantum-mechanical 'tunnel effects', which would actually be extremely small, on account of the large masses involved.

After division, the high neutron/proton ratio of uranium will tend to readjust itself by beta decay to the lower value suitable for lighter elements. Probably each part will thus give rise to a chain of disintegrations. If one of the parts is an isotope of barium[5], the other will be krypton ($Z = 92 - 56$), which might decay through rubidium, strontium and yttrium to zirconium. Perhaps one or two of the supposed barium-lanthanum-cerium chains are then actually strontium-yttrium-zirconium chains.

It is possible[5], and seems to us rather probable, that the periods which have been ascribed to elements beyond uranium are also due to light elements. From the chemical evidence, the two short periods (10 sec. and 40 sec.) so far ascribed to ^{239}U might be masurium isotopes ($Z = 43$) decaying through ruthenium, rhodium, palladium and silver into cadmium.

In all these cases it might not be necessary to assume nuclear isomerism; but the different radioactive periods belonging to the same chemical element may then be attributed to different isotopes of this element, since varying proportions of neutrons may be given to the two parts of the uranium nucleus.

By bombarding thorium with neutrons, activities are obtained which have been ascribed to radium and actinium isotopes[8]. Some of these periods are approximately equal to periods of barium and lanthanum isotopes[5] resulting from the bombardment of uranium. We should therefore like to suggest that these periods are due to a 'fission' of thorium which is like that of uranium and results partly in the same products. Of course, it would be especially interesting if one could obtain one of these products from a light element, for example, by means of neutron capture.

It might be mentioned that the body with half-life 24 min.[2] which was chemically identified with uranium is probably really ^{239}U, and goes over into an eka-rhenium which appears inactive but may decay slowly, probably with emission of alpha particles. (From inspection of the natural radioactive elements, ^{239}U cannot be expected to give more than one or two beta decays; the long chain of observed decays has always puzzled us.) The formation of this body is a typical resonance process[9]; the compound state must have a life-time a million times longer than the time it would take the nucleus to divide itself. Perhaps this state corresponds to some highly symmetrical type of motion of nuclear matter which does not favour 'fission' of the nucleus.

LISE MEITNER.

Physical Institute,
Academy of Sciences,
Stockholm.

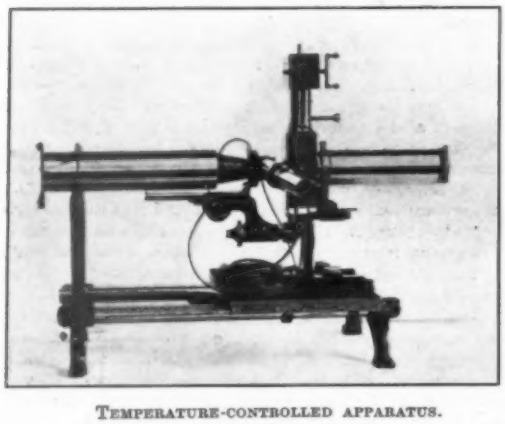
O. R. FRISCH.

Institute of Theoretical Physics,
University,
Copenhagen.
Jan. 16.

[1] Fermi, E., Amaldi, F., d'Agostino, O., Rasetti, F., and Segrè, E. *Proc. Roy. Soc.*, A, **146**, 483 (1934).
[2] See Meitner, L., Hahn, O., and Strassmann, F., *Z. Phys.*, **106**, 249 (1937).
[3] Curie, I., and Savitch, P., *C.R.*, **208**, 906, 1643 (1938).
[4] Hahn, O., and Strassmann, F., *Naturwiss.*, **26**, 756 (1938).
[5] Hahn, O., and Strassmann, F., *Naturwiss.*, **27**, 11 (1939).
[6] Bohr, N., NATURE, **137**, 344, 351 (1936).
[7] Bohr, N., and Kalckar, F., *Kgl. Danske Vid. Selskab, Math. Phys. Medd.*, 14, Nr. 10 (1937).
[8] See Meitner, L., Strassmann, F., and Hahn, O., *Z. Phys.*, **109**, 538 (1938).
[9] Bethe, A. H., and Placzek, G., *Phys. Rev.*, **51**, 450 (1937).

A Novel Thermostat

IT is often necessary to maintain an apparatus at a constant temperature. This may be done by immersing it in a circulating liquid maintained at a constant temperature by a thermostat, or by jacketing



TEMPERATURE-CONTROLLED APPARATUS.

it with alternate shells of thermally conducting and insulating materials heated to the selected temperature by means of an internal electric heater. These methods have the disadvantages that the thermostatic system makes the apparatus less accessible, the control of the temperature to within a narrow range requires some complication in the whole system, and it is difficult to prevent 'hunting'.

In a measurement which we are making of the electronic charge, it is necessary to maintain the temperature of the air, in which an oil drop moves, uniform and constant so that it has no motion due to convection. As a convenient solution of this problem has been found which seems capable of many applications, it is described here.

A resistance thermometer is formed by winding a single layer coil of copper wire around and in good thermal contact with the microscope condenser which forms part of the apparatus the temperature of which is under control. (In the accompanying illustration the condenser tube is on the right.) This coil forms one arm of a Wheatstone bridge, the other arms being of manganin resistances. Any change in temperature of the apparatus deflects the light spot of the galvanometer connected to this bridge, and for one direction of deflection the spot falls on a photo-electric cell, which operates a polarized relay, which in turn puts off two 30-watt lamps placed on opposite sides of the apparatus. The amplification of the galvanometer current by the photo-electric cell is 10^6, and including the relay about 10^7.

The bridge is adjusted to be balanced at a temperature a few degrees above the maximum temperature to which the room rises during a day. The lamps flash on and off every few seconds and maintain the temperature of the external surface of the apparatus constant to about 0·002° C. After the thermostat has been in operation for an hour, we have not been able to detect, by means of a thermo-couple, any change of temperature inside the apparatus.

T. H. LABY.
V. D. HOPPER.

Natural Philosophy Laboratory,
University of Melbourne.
Dec. 9.

Limitations on the Modern Tensor Scheme of Relativity

IT does not appear to have been noticed by anybody that the tensor scheme of relativity is incompetent by itself to include relations of chirality, to use Lord Kelvin's term. For it is developed from a pure Riemannian geometry, as based solely on the use of an ideal mobile a-chiral linear measuring rule. The meaning of relativity has, of course, always been that knowledge consists of the relations of one system to another, especially when one type of system of high simplicity, such as the linear measuring rule, is taken as the standard of comparison for all others. This significance of the chiral property, which is the difference between a chiral system and its mirror-image, for example, between a right-hand glove and a left-hand, goes back to Kant's early writings, and remained fundamental in his trains of thought in relation to space and time; later, in the more amateur hands of Pasteur, it created a fundamental science. Chiral systems can be compared completely only with chiral systems. The frame of reference for a chiral system must itself have chiral property; for example, to be effective, the mobile measuring rod of Einstein would require to possess a screw structure essential to it. When Newton explained how he could tell by experiment

whether his space was rotating, he was perhaps not so far out after all.

It may appear that this argument presents a demurrer to the theory which derives the space-time scheme from the single mental foundation of linear succession in a time which is absolute for all observers everywhere: but it is to be remembered that the assertion of a scalar constant velocity of radiation is there the fundamental postulate. Chiral properties, of the two conjugate types, would thus have to be restricted to imbedded atomic structures. Likewise to our universe based mainly on negative electrons there ought in theory to be a conjugate universe, its mirror-image, based on positive: and to our organic nature based on læval chiral structures there ought in theory to be a conjugate one, its mirror-image, based on dextral.

On the other hand, it is perhaps not easy to see how the tensors can escape the fate that is reserved for all 'unobservables', unless a set of observing apparatus can be devised which is itself beyond the bounds of space and time.

Or may we find refuge in the doctrine that physical science, being concerned largely with statistical aggregates, is unable to construct laws or relations without allowing substantial margins for inherent 'uncertainties' (cf. Laplace on "Probabilities").

Also, co-ordinates must surely be defined or restricted by laws of continuity. All significant tensors would have to be invariant for every linear vector change in the frame of reference; but their components would by no means be separately invariant, thus the energy in a generalized sense which is the final component of the energy-tensor would have no reality. Yet notwithstanding this want of detailed invariance, the vanishing of the complete tensor involves (after Einstein) the separate vanishing of all its components, so would express one law of Nature built on this type, by a representative group of as many simultaneous differential equations as the vanishings provide.

JOSEPH LARMOR.

Holywood,
N. Ireland.
Jan. 2.

Theory of Mesons and Nuclear Forces

As was first pointed out by Yukawa, it is in principle possible to account for the short-range forces between nuclear particles by the assumption of virtual emission and absorption processes involving intermediary particles of integral spin, the so-called *mesons*[1], the mass of which is determined by the range of the forces. As has been shown by Kemmer[2], the simplest wave-equations for the mesons which satisfy, besides the claim of relativistic invariance, the condition of giving a positive definite expression for the energy, reduce to four types, characterized by different co-variance properties of the wave-functions, and each allowing the existence of neutral as well as positively and negatively charged mesons. Starting from such wave-equations, including the interaction of the meson field with the heavy nuclear constituents, the estimation of the resulting expressions for the nuclear forces has hitherto been carried out by using the ordinary perturbation method of quantum theory, and taking into consideration only the first non-vanishing approximation, in spite of the well-known lack of convergence of the method. It would thus seem desirable to discuss more closely the reliability of such results, and for this purpose a possible method of attack is suggested by an analogous situation in quantum electrodynamics, where a suitable canonical transformation allows us to separate, from the expression of the total energy of a system consisting of electrons and an electromagnetic field, a term depending only on the co-ordinates of the electrons and representing the Coulomb potential energy.

A similar method[3] is, actually, applicable to a system consisting of nuclear particles and a meson field. For such a system it is, in fact, possible to find canonical transformations effecting the separation of a 'static' interaction between the nuclear particles, defined as the part of the interaction which is obtained when one neglects the time-variations of the variables characterizing the positions, spins and proton or neutron states of the heavy particles. This static interaction is in all cases exactly the same as that obtained as a first approximation in the perturbation method, and there exists a lower limit, smaller but unfortunately not much smaller, than the range of the nuclear forces, to the mutual distances between two heavy particles for which the static interaction is more important than the additional non-static contributions arising from the terms, in the transformed Hamiltonian, which describe the remaining interactions between the heavy particles and the meson field.

Although no improvement can, of course, be obtained in this way as regards the self-energy difficulties, it would seem that consistent results can be derived from the transformed Hamiltonian by considering only the last-mentioned interactions as a perturbation and applying a method of treatment analogous to the correspondence methods used in electrodynamics. It is especially to be noted that if, following Yukawa, we also introduce an interaction between the meson field and electrons and neutrinos, the transformed Hamiltonian contains a term which represents a direct interaction between the heavy particles and the electrons and neutrinos, and which, when treated as a small perturbation, immediately gives the probabilities of β-disintegration processes. It is perhaps to be regarded as a satisfactory feature of the point of view just outlined that, contrary to previous treatments, where the nuclear forces came out in the same stage of the perturbation method as the probabilities of β-decay, account is here taken at the outset of at least the static part of the nuclear forces.

As regards the form of these static interactions, it is well known that the type of potential resulting from the four-vector meson field generally considered hitherto has the defect of including a term of dipole interaction energy which is so strongly singular for infinitely small mutual distances of the nuclear particles that it would not in general allow the existence of stationary states for a system of such particles. In order to remedy this defect, it seems necessary[3] to introduce besides the four-vector wave-function a further pseudoscalar wave-function for the meson field which has the property of giving rise to a static interaction of a form just capable of cancelling the dipole interaction term without affecting the others. The consideration of such a pseudoscalar meson field would also seem to be useful from the point of view of the theory of β-decay. While, for example, the four-vector theory yields[4] exactly the same form of the β-spectrum as Fermi's original

theory, the introduction of a pseudoscalar wave-function in addition to the four-vector one gives rise to a modification of the energy distribution of the β-rays which seems to open a new possibility of a better adaptation to the experimental results.

A detailed account of our work will appear shortly in the *Proceedings of the Copenhagen Academy*.

C. MØLLER.
L. ROSENFELD.

Institute for Theoretical Physics.
Copenhagen.
Jan. 6.

[1] See Bhabha, NATURE (in the Press).
[2] Kemmer, *Proc. Roy. Soc.*, A, **166**, 127 (1938); *Proc. Camb. Phil. Soc.*, **34**, 354 (1938).
[3] Independently of our work, essentially the same method has been proposed by Stückelberg (*Phys. Rev.*, **54**, 889; 1938), to whom we are very thankful for the kind communication of his manuscript.
[4] Yukawa, Sakata, Kobayasi, Taketani, *Proc. Phys. Math. Soc. Japan*, **20**, 720 (1938).

Frequency Interpretations in Probability

THE letter of mine quoted by Dr. W. E. Deming[1] was mostly in the nature of a personal explanation. I have never denied that frequencies may be *relevant to* a prior probability; what I deny is that a frequency is ever the *whole content* of a probability, whether prior, direct or posterior. I have, in fact, pointed out that prior probabilities should be reassessed from time to time to allow for accumulation of information from analogous problems, and the case considered by Deming is an extreme one of this type, since the balls in his box are derived from a large population the composition of which is definitely known. The kind of distinction involved seems to have been noticed by Laplace, if one compares his opening remarks with those of De Moivre. De Moivre begins by defining a probability as simply the ratio of the number of favourable cases to the whole number of possible cases. Laplace puts in the proviso "provided that all the cases are equally possible"; otherwise his statement is practically a translation of De Moivre's.

Consider the following problem. A box contains one white and two black balls; another contains one white and one black. A box is to be chosen at random and then a ball at random from that box. What is the probability that the ball will be white? According to De Moivre's definition, it is the number of white balls divided by the whole number of balls, and therefore is 2/5. All balls are possible and there is no alternative. But I think that any modern writer would say that the probability is $\frac{1}{2}.\frac{1}{3}+\frac{1}{2}.\frac{1}{2}=5/12$, and indeed that De Moivre would have said so if the point was put to him. The correct result can be got only by recognizing that the five balls are not "equally possible". Though Laplace is liable to be too brief in places and by modern standards too prolix in others, I think it must be inferred from the comparison of the statements that he had seen that the earlier definition did not cover actual needs, and could be made to cover them only by means of the idea of "equally possible", which is not defined as such. It cannot be defined in terms of frequency and must be taken as a primitive notion.

Now Dr. Deming's presentation involves the same idea, through the notion of randomness, which is not defined. A mere statement of the numbers in the parent population is not enough to ensure randomness. For example, some adhesive might be present that sticks to the white balls and not to the black ones. Then the extraction of a white ball would tend to pull others to the top, and we should expect a disproportionate number of white balls in a large sample, even although we might be unable to rule out any particular selection as impossible. In fact, the force of the treatment is not in the ratio of the numbers, but in the undefined notion of randomness, which is equivalent to "equally possible"—that is, that all selections from the parent population are equally likely. Without this idea, which may be part of a frequency *treatment*, but is not part of a frequency *definition*, we cannot say anything about what the result of a trial is likely to be. If anybody says that we will go on picking out white balls until there is none left, a frequency interpretation by itself provides no answer. It is possible in logic and there the matter ends. Similarly, no meaning could be attached to differences of possible biases in a coin; so long as it is in the least possible for either a head or a tail to occur, the probability, on the frequency definition, is $\frac{1}{2}$.

Of course I agree that there are cases where it is reasonable to expect that the ratio in a large sample will approximate to that in the population; but my point is that if we do that, we are taking "reasonable to expect" as a primitive idea, and it should be stated as such. No practical recommendation can ever be used unless this idea is brought in, though it is liable not to be mentioned by the statistician. That makes no difference in practice because, even if the statistician does not mention it, the person advised uses it. Without it, the latter would be entitled to say: "That is all very well as a piece of pure mathematics, but what has it to do with me?"

I should say myself that the hypothesis of randomness is always what logicians call a *considered* proposition, not an *asserted* one. The point of any type of significance test is to examine cases where the hypothesis may be untrue. It may in fact always be false—if a coin is thrown enough times it will wear and become biased; if a pack of cards is dealt often enough it will become marked and too many aces will go to the dealer, and so on. But it has the advantage that it involves the minimum number of parameters, since it does not need the introduction of one or more parameters to express possible bias or dependence of one trial on the results of previous trials. Consequently it is easy to state, and in actual cases easily discarded if it is found to be unsatisfactory; even if it is untrue it points the easiest way of progress. But it should not be stated as a fact, and if anybody proposes, in order that a frequency definition may give acceptable answers, to restrict himself to cases where randomness holds, he is both using the notion of reasonable degree of belief and artificially restricting its application.

HAROLD JEFFREYS.

St. John's College,
Cambridge.

[1] NATURE, **143**, 202 (1939).

Antarctica and Glacial Ages

PROF. A. P. COLEMAN[1] contends that the late Palæozoic glacials of the southern hemisphere could never have been formed upon a large, single continent —Gondwana—as visualized by supporters of the hypothesis of continental drift. He has protested that, for such an ice-cap to have developed, there must have been sources of evaporation at hand in

the shape of warm seas, and has accordingly denied the existence of any such continent and along with it the hypothesis of drift. It is difficult to follow his argument in the face of recent work on this problem.

The mere presence of sea—whether warm or cold—would be no measure of the rainfall upon the adjacent lands, as witness the large desert regions along the coasts of South America, Africa and Arabia. A more important part must be played by the atmospheric circulation.

The coldest place in the world, stated by Prof. Coleman to have escaped glaciation during the Pleistocene, is situated right between the Arctic Ocean and the Sea of Okhotsk, only a short distance from either. The centre of the mighty Antarctic ice-cap is fully 1,500 miles from the encircling chilly ocean, where evaporation cannot surely be large.

According to Antevs the Pleistocene ice-cap was several times larger, but, even assuming with Prof. Coleman that the North American portion was unconnected with those of Europe or the Arctic, that body was still more than two thousand miles across, wholly eccentric to the pole and bounded on the south by a wide strip of continent.

It would seem not unreasonable to argue that during a major glacial period ice could have accumulated in a co-polar position up to at least two thousand miles back from the ocean margin, provided that the atmospheric and oceanic circulations and the solar radiation were favourable.

Applying this to the Permo-Carboniferous epoch, and consulting the reconstruction formerly given by me[2], it will be discovered that no part of the great hypothetical ice-cap need have been more than some 1,700 miles from the nearest ocean, the existence of which is indicated by marine deposits, in several cases intercalated in or immediately succeeding the glacials, as mentioned by Prof. Coleman. Such strata were clearly laid down in bays and gulfs penetrating into a low-lying continent or assembly of continents.

There is positive evidence of the successive overlapping of ice-bodies, while it is furthermore unlikely that the entire territories known to have been affected were ever completely ice-covered at one and the same time—precisely as in the case of the Pleistocene glaciation. It is logical to presume—and the geological evidence is in agreement therewith—that the ice started collecting at isolated points, that such bodies increased in size and that the weighting of the continent by snow helped to cause depression and invasion by the sea, with rapid expansion of the ice-caps and their ultimate coalescence. It is unnecessary to suppose that such a continent was pushed polewards for each glaciation and pulled back for each interglacial phase. The observed phenomena could more intelligently be explained by fluctuations in solar radiation, etc. There is internal evidence also to suggest that the Permian coals of Gondwana, unlike the Carboniferous seams of the northern hemisphere, were cold climate interglacial or post-glacial accumulations.

In his monograph[3], Prof. Coleman has deplored not being able to explain the distribution of past glacial deposits, which suggests that he must have overlooked some vital factor. Others too have failed to interpret such glacial phenomena in terms of existing geographical and meteorological environments.

The hypothesis of drift endeavours to explain the Permo-Carboniferous glacials as formed around the south pole of that period, upon a reassembled Gondwana, though not centrally thereon, and with adequate oceanic areas at hand for the required evaporation. The principle can furthermore be invoked to account for the still older glacials that, significantly, lie within the very region affected during the Palæozoic, of which at least five groups of widely different ages are known in southern Africa alone.

Instead of contending that the Permo-Carboniferous glacials could not have been developed upon a single land-mass, as he does, I feel it would be more helpful if Prof. Coleman could show how they could have been laid down at all in the several widely-parted areas in the positions and latitudes which they occupy to-day.

In the various orogenic zones of the earth, for example, in the Appalachian region, hundreds of miles of horizontal sediments have been compressed laterally into a fraction of the space originally occupied by them. When a convincing explanation can be given of how such could have happened, and also what material now fills the corresponding gap in the earth's circumference whence the crumpled-up strata came, an answer should be forthcoming for the elusive mechanism of continental drift.

ALEX. L. DU TOIT.

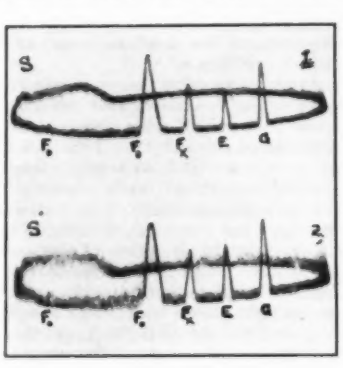
P.O. Box 4565,
Johannesburg.

[1] NATURE, 142, 998 (1938).
[2] "Our Wandering Continents". Fig. 9 (1937).
[3] "Ice Ages, Recent and Ancient" (1926).

Scattering of Radio Waves in Polar Regions

THE interesting letter by Harang and Stoffregen[1], concerning ionospheric radio wave reflections at Tromsø, prompts the recollection of some observations made by us at the same observatory during the Second International Polar Year, 1932–33, on a type of radio echo which seems peculiar to polar regions.

A reproduction of the radio echo delineation observed at Tromsø using 4·0 Mc./s. waves at 1600 M.E.T. on July 31, 1933, is shown in the



accompanying figure. (In this figure the cathode ray spot provides a time-scale trace by moving around the depicted ellipse in a right-handed fashion.) It will be seen that in addition to echoes from Regions *E* and *F*, there is also a distorted echo *S* with a delay time of 7·5–9·5 milli-seconds, indicating reflection or scattering at a distance of 1,125–1,425 km. from the sending and receiving stations. The special interest of the record, however, arises from the fact that it is

possible in this case to decide whether the echo is due to reflection at vertical incidence or to sideways scattering. Since both first and second order reflections from Region *F* are present, we know that the frequency used is less than the critical penetration value for that region. Moreover, since Region *F* is known to be thick, when measured in terms of a vacuum wave-length, we know that there can only be negligible penetration of the region for frequencies less than the critical value. We can therefore conclude that the echo *S* is due to sideways scattering from some complex ionized centre situated in or below the normal Region *F*, and is not due to reflection from very great heights. In this connexion it may be recalled that Appleton and Piddington[2] have shown that the principal scattering centres of the ionosphere are situated at levels between 80 km. and 160 km. above the ground.

E. V. APPLETON.
R. NAISMITH.

Cavendish Laboratory,
Cambridge.
Jan. 6.

[1] NATURE, 142, 832 (1938).
[2] *Proc. Roy. Soc.*, A, 164, 467 (1938).

Electric Charge on Soft Hail

IN the course of measurements of the electric current carried down to the earth by precipitation, there have occurred occasions when the results are considered worthy of attention.

On December 19, 1938, during a sharp shower of soft hail (graupel), from cumulo-nimbus clouds, the charge brought down to an area of about 1 metre square in the ten-minute period 12.56–13.06 amounted to more than $-4{\cdot}4 \times 10^{-5}$ coulombs, corresponding to an average current of more than $-7{\cdot}3 \times 10^{-12}$ amp./cm.^{2}. This appears to be a larger precipitation current than has ever been previously observed. Over an area of 1 km.^{2} this amounts to a charge of -44 coulombs in the ten minutes, which may be compared with a value of $+35$ coulombs for the fine-weather current for a whole year, as obtained from the results of Scrase[1].

This particular occasion gave a larger current than in other cases, but there also occurred, on the same and the following day, average currents over a ten-minute period of $+3{\cdot}8$, $+1{\cdot}1$, $-0{\cdot}8$ (twice), $+0{\cdot}7$ and $-0{\cdot}7$, as well as many others greater than $\pm 0{\cdot}1$, the unit in each case being 10^{-12} amp./cm.^{2}; in addition, there were occasions when the currents were not recorded, and these may have been large currents. In the parts of the earth where such showers are frequent, particularly at high altitudes and in high latitudes, it is probable that the charges brought down to the earth will be very considerable, and will be of much importance in the discussion of the maintenance of the negative charge on the earth's surface. It is therefore desirable that similar measurements should be carried out at such places, if opportunity offers.

J. A. CHALMERS.
E. W. R. LITTLE.

Physics Department,
Science Laboratories,
Durham.

[1] Scrase, F. J., *Geophys. Mem.*, 58 (1933).

Catalytic Exchange of Deuterium and Hydrogen in Hydrocarbons

CATALYTIC interchanges of hydrogen atoms between molecular hydrogen and hydrocarbons of the type $RH + D_2 = RD + HD$ have already been repeatedly observed[1–3]. The following instances of catalytic exchange seem of special interest as they proceed rather rapidly under mild experimental conditions and give important indications as to the mechanism of exchange reactions in general.

If a mixture of deuterium and cyclohexane or *n*-hexane vapour is brought into contact with a platinized platinum foil (10 mm. × 10 mm.)[3], an interchange of hydrogen atoms takes place at the following speeds:

Reaction volume, 78 c.c.; total pressure, 80 mm. mercury.

Mixture	Temperature (° C.)	Half-period of exchange (min.)
Cyclohexane-deuterium	37	120
	65	23
	97	11
Hexane-deuterium	55	33
	82	11
	124	3

In each case, the exchange can be followed up until the exchange equilibrium is completely established. Under the given experimental conditions, no chemical change other than exchange occurs. In the case of the cyclohexane, it can be shown that the establishment of the equilibrium $C_6H_{12} = C_6H_6 + 3H_2$ cannot account for the observed exchange. The mechanism of these exchange reactions seems to involve the detachment of one hydrogen atom from the hydrocarbon, as was suggested for the exchange reactions of ethylene and benzene[5]. It is most probable that the same mechanism is operative in the exchange reactions of all kinds of saturated and unsaturated hydrocarbons in general.

Finally, it may be mentioned that the present experiments offer a convenient method for the preparation of deuterated hydrocarbons.

L. FARKAS.
A. FARKAS.

Department of Physical Chemistry,
Hebrew University,
Jerusalem.
Jan. 1.

[1] Farkas, Farkas and Rideal, *Proc. Roy. Soc.*, A, 146, 630 (1934).
[2] Horiuti, Ogden and Polanyi, *Trans. Farad. Soc.*, 30, 663 (1934).
[3] Morikawa, Benedict and Taylor, *J. Amer. Chem. Soc.*, 58, 1445, 1795 (1936).
[4] Morikawa, Trenner and Taylor, *J. Amer. Chem. Soc.*, 59, 1103 (1937).
[5] Farkas and Farkas, *Trans. Farad. Soc.*, 33, 678, 827 (1937).

Availability of Phosphorus in Rice

A LARGE proportion of the phosphorus present in rice, as in all other cereals, exists as the poorly utilizable phytin[1], and to this fact is ascribed the rachitogenic action of cereal diets[2].

In investigations on the nutritive value of rice varieties[3], I observed that the average growth-rates induced in groups of young rats fed solely on the different rice varieties, together with adequate supplements of all the vitamins, were essentially related to their contents of proteins and minerals, particularly phosphorus. In the following test, an attempt was made to determine the growth-promoting qualities of the phosphorus compounds in two varieties of rice

the chemical composition of which, in percentages, is given below :

Variety	Moisture	Protein (N × 6·25)	Ether extractives	Carbohydrates	Total minerals	P_2O_5	CaO
Adt. 6	11·2	7·70	2·34	74·8	1·64	1·14	0·09
Adt. 11	12·4	5·77	2·28	77·7	1·28	0·61	0·08

The powdered rices were used for feeding, but in one case (Adt. 11) the rice flour was intimately mixed with 2 per cent of a preparation of rice protein (purity = 94 per cent) so that the protein contents of the two feeds were nearly the same. The rices were then mixed with 5 per cent of a *phosphate-free* salt mixture composed of calcium lactate (150 parts), magnesium sulphate (30 parts), ferric citrate (12 parts), sodium chloride (10 parts) and potassium chloride (10 parts).

Groups of four young rats were fed on the two diets thus prepared, together with the same supplements of cod liver oil and 'Marmite' extract. The experiment was continued for a period of six weeks. The average weekly growth-rates (increase in weight in grams) were as follows :

Rice	1	2	3	4	5	6
Adt. 6	13·2	12·6	10·8	8·4	7·0	6·2
Adt. 11	9·6	10·4	8·4	6·8	5·4	5·0

In spite of the protein contents having been adjusted to the same level in both the diets, there is observed a definite difference in growth-rate due to the two varieties of rice. This is evidently traceable to the differences in the mineral contents of the grains. Since the salt mixture used contained enough supplements of all the minerals excepting phosphorus, it is reasonable to assume that the better growth induced by Adt. 6 is due to its containing more (about 1·9 times) phosphorus than Adt. 11.

The presence of a phytase in the intestines of the rat[4] and its possible significance in rendering available the phytin to the animal organism have been indicated, but the evidence is yet inconclusive[5]. The present note would point to the need for further work in this direction.

A. SREENIVASAN.

Department of Biochemistry,
Indian Institute of Science,
Bangalore.
Dec. 6.

[1] Bruce, H. M., and Callow, R. K., *Biochem. J.*, **28**, 517 (1934); Widdowson, E. M., and McCance, R. A., *Biochem. J.*, **29**, 2694 (1935); Lowe, J. T., and Steenbock, H., *Biochem. J.*, **30**, 1126 (1936).

[2] Mellanby, E., *Med. Res. Council, Spec. Repts. Series*, No. 93 (1925); Mellanby, M., *Med. Res. Council, Spec. Repts. Series*, No. 140, chapter v (1929).

[3] *Ind. J. Agric. Sci.* (in the Press).

[4] Patwardhan, V. N., *Biochem. J.*, **31**, 560 (1937).

[5] Lowe, J. T., and Steenbock, H., *Biochem. J.*, **30**, 1991 (1936).

Self-Sterility in *Œnothera*

Œnothera missouriensis is a species with flowers of maximum size. It, and certain related species[1], extend from Missouri through Oklahoma, Texas and adjacent regions in the western States. It differs from ordinary species in being perennial and in developing enormous wings on the fruits. The seeds are also very much larger and fewer. Because of these characters it has been placed by some in a separate genus, *Megapterium*. Unlike most of the true *Œnotheras*, which have developed catenation of their chromosomes in meiosis, *O. missouriensis* was found to have seven free pairs[2].

For several years a plant has been grown at the Courtauld Laboratory, Regent's Park, and as it bore no fruits nor seeds efforts have been made every year to obtain seeds by selfing the flowers by hand. Not a single flower, however, set seed, whether hand pollinated or not, although a large number of flowers bloomed every year. This finally led to the conclusion that the species was probably self-sterile. Last summer this was confirmed by pollinating the flowers from a strain grown at the Merton Laboratory. Four flowers were cross-pollinated and they all showed a good setting of seeds.

Some strains of the species have round red spots on the sepals, and this was true of the Regent's Park plant, while the sepals of the plant from Merton were devoid of the red spots. Certain other differences were also observed, the inheritance of which will be studied.

It thus appears that while the subgenus *Onagra* has developed chromosome catenation as a mechanism for maintaining a heterozygous condition in its species, the subgenus *Megapterium* has produced the same result by developing a mechanism of self-sterility.

R. RUGGLES GATES.

King's College,
London.
Jan. 26.

[1] *Ann. Missouri Bot. Gard.*, **1**, 401–404 (1914).

[2] Hedayetullah, S., "Meiosis in *Œnothera missouriensis*", *Proc. Roy. Soc.*, B, **113**, 57–70 (1933).

Induction of Polyploidy in Chilli (*Capsicum annuum* L.) by Colchicine

THE discovery by Blakeslee[1] in 1937 that treatment with colchicine induces doubling of chromosomes in plant cells, leading to the production of polyploids, is of practical importance to the breeder who is faced with the problem of sterility in hybrids from wide crosses, arising from the different material constitution of the chromosomes of the parents. Except in those cases where sexual propagation made possible their utilization, it has not hitherto been possible to take full advantage of such crosses. The results of experiments so far carried out with colchicine, although mostly of a preliminary nature, have raised hopes of producing vigorous fertile forms from sterile hybrids, and several workers, notably Dermen[2] (1938), Nebel and Ruttle[3] (1938), Levan[4] (1938) and Kostoff[5] (1938), have repeated the experiments of Blakeslee and reported favourably regarding the efficacy of this alkaloid in producing polyploids.

The study of the effects of this chemical on several economic species of plants has been undertaken and a preliminary account of results obtained with chilli is here reported. Seeds were immersed in 0·05 per cent, 0·1 per cent, 0·2 per cent and 0·4 per cent solutions of colchicine in water for 1, 2, 4, 6 and 8 days and planted in the field with controls. While the control plants were normal in growth and flowered almost at the same time, some of the treated plants showed various degrees of abnormality of growth in the early stages such as roughening and

thickening of the leaves, fasciation of stems and other vegetative organs and doubling of flowers. These were generally slow growing, developed broad and succulent leaves and flowered later than the controls and had varying percentages of sterile pollen, the fertile pollen being nearly double the volume of the pollen of normal plants. The seed setting was considerably reduced in such plants as compared with the normal plants. The abnormal plants on examination by aceto-carmine smears of pollen mother cells proved to be tetraploids. Polyploids of higher order than tetraploids was not observed although $2n$ and $4n$ tissue was found to occur in the same plant in some cases. The accompanying table gives the number of diploids and tetraploids occurring in the different treatments.

Strength of aqueous solution of colchicine	0·05 per cent			0·1 per cent			0·2 per cent			0·4 per cent		
Period of immersion of seed in colchicine	Diploids	Polyploids	Per cent of Polyploids	Diploids	Polyploids	Per cent of Polyploids	Diploids	Polyploids	Per cent of Polyploids	Diploids	Polyploids	Per cent of Polyploids
1 day ..	27	2	6·9	20	1	4·8	4	11	73·3	4	6	60·0
2 days ..	19	4	17·4	20	3	13·0	5	11	68·8	2	5	71·4
4 days ..	5	3	37·5	5	2	28·6	1	4	80·0	1	—	—
6 days ..	16	3	15·8	8	4	33·3	2	2	50·0	4	4	50·0
8 days ..	9	4	30·8	4	6	60·0	7	1	12·5	2	1	33·3

Besides the tetraploids, one triploid was also identified among the treated plants. It is at present not possible to say if this arose spontaneously or as a result of the treatment. In addition to polyploids, we have isolated a few diploids among the treated plants showing meiotic irregularities leading to the formation of sterile pollen. A further account of these and the tetraploids will be reported elsewhere.

B. P. PAL.
S. RAMANUJAM.
Imperial Agricultural Research Institute,
New Delhi.
Dec. 13.

[1] Blakeslee, A. F., and Avery, A. G., *J. Hered.*, **28**, 393–412 (1937).
[2] Dermen, H., *J. Hered.*, **29**, 211–229 (1938).
[3] Nebel, B. R., and Ruttle, M. L., *J. Hered.*, **29**, 3–9 (1938).
[4] Levan, A., *Hereditas*, **24**, 471–486 (1938).
[5] Kostoff, D., *Curr. Sci.*, **6**, 549–552 (1938).

Period of Gestation of *Loris*

IN a recent communication[1], Dr. W. C. O. Hill suggests from certain evidence that "the gestation period [in *Loris*] is somewhere in the neighbourhood of six months". The following history of a pair of lorises will be of interest, and confirms Dr. Hill's opinion.

Lorises had not been found in Ceylon above about 3,000 ft., where a race occurs differing from the common low-country loris in a few details: it has been named *L. tardigradus grandis*. In May 1937, Mr. A. C. Tutien-Nolthenius sent me two large lorises which had been caught on his estate near the Horton Plains at a height of between 5,000 ft. and 6,000 ft. They are robustly built and have very thick and long fur, and may be considered an extreme type of *L. t. grandis*. These were kept in a large cage (6 ft. square), and in June I introduced into the cage for the purpose of comparison a male which had been caught at 3,000 ft. This male happened to be 'in season', and fighting took place between the two males, so that I was obliged to remove the one newly introduced. I noticed the next day that the high-country male had come 'into season'. It may have been stimulated by the presence of the other male. I am familiar with two sounds made by lorises, the first is a hissing sound made when they are quarrelling or frightened, and the second is a low call which can be heard from a much greater distance. On the night of June 23, I heard sounds coming from the cage; these so closely resembled mewing that I thought a kitten was in or on the cage, but on investigation I found that the lorises were mating, and both were emitting the mewing sound. They have been carefully watched from that date. The male has not come 'into season' again. On December 14 the female gave birth. Therefore the period of gestation was 174 days, which is about one week short of six calendar months.

The young loris is about the size of a half-grown mouse; and it is carried about clinging to the hair of the mother's abdomen.

LUCIUS NICHOLLS.
Institute of Bacteriology,
Colombo, Ceylon.
Dec. 20.

[1] NATURE, **136**, 107 (1935).

The 'Thumb' of the Giant Panda

THAT Mr. Pocock (see NATURE, Feb. 4, p. 206) finds the radial sesamoid and the palmar pad that covers it are "capable of only slight movement" in the dead specimen may perhaps be explained in part by the rigidity of the tissues in the undissected cadaver. For most certainly, during the progress of dissection, a very high degree of mobility is demonstrated; and even in the bones themselves, the same fact is attested to in the large, bevelled cartilage-covered joint surface between the scapholunar and the sesamoid.

Moreover, Mr. Pocock overlooks the most interesting facts in this remarkable adaptation—that powerful muscles inserted to the mobile thumb in normal mammals are, in the giant panda, inserted to the mobile sesamoid, while thumb muscles arising from the fixed trapezium in normal mammals are here transferred to the mobile sesamoid. The whole muscular and articular adaptation is towards the end of producing movements of the sesamoid, and of its free mobility there can be no question.

When Mr. Pocock declares the mechanism in the panda to be "exactly comparable to that produced by bringing the tips of the first and second fingers on to the ball of the thumb in the human hand", he is stating an obvious truth; but he seems to overlook the fact that, like the panda's radial sesamoid, the metacarpal of the human thumb is also mobile.

F. WOOD JONES.
The University,
Manchester, 13.
Feb. 3.

Electrified Motor-Vehicles

WHILE to experience an electric shock from a motor-vehicle appears from a recent note to be unusual in England[1], it is so common in the United States as to call for no comment. An interesting consequence of this phenomenon is to be seen on the San Francisco-Oakland and Golden Gate Bridges, where thousands of cars a day pass the toll gates and where the continuous small shocks suffered by receivers of toll on touching coins handed to them by drivers of cars have proved very unpleasant. Wire brushes standing about one foot high have accordingly been installed immediately before all toll gates so that cars as they approach are relieved of their accumulated charges. In at least one toll station in this country a jet of water is sprayed on the wheels of approaching cars for the same purpose.

In many States and municipalities there is a law compelling vehicles carrying petrol and similar inflammable products to drag chain behind them in order to discharge continuously any electrostatic charge of the vehicle. On a dark night I have seen a continuous glow coming from such chains dragging over asphalt roads, quite different in appearance from sparks which might be produced by striking stones. In the State of Massachusetts, however, I understand there is a law prohibiting drag chains on the grounds that the frictional or electrical sparks so generated might ignite a leaky truck.

E. C. WILLIAMS.

Shell Development Company,
Fifty-third Street,
Emeryville,
California.
Dec. 27.

[1] NATURE, 142, 713 (1938).

Points from Foregoing Letters

FOLLOWING upon Hahn and Strassmann's observation that isotopes of barium are probably formed when uranium is bombarded with neutrons, Prof. Lise Meitner and Dr. O. R. Frisch discuss a new type of nuclear reaction in which a heavy atomic nucleus after taking up a neutron splits into two roughly equal nuclei, very much as a drop of water breaks into two when its size is large and its surface tension is low. In the case of uranium, if one of the new atoms formed is barium the other will be krypton. Thorium apparently breaks up into barium and lanthanum isotopes.

A new thermostatic arrangement for keeping apparatus at constant temperature within 0·002° C. without the necessity of careful insulation or surrounding with a circulating liquid, is described by Prof. T. H. Laby and V. D. Hopper.

Sir Joseph Larmor points out that the tensor scheme of relativity cannot by itself deal with the relation of an asymmetrical object to its mirror image. To be effective for this purpose, the mobile measuring rod of Einstein would have to possess a screw structure essential to it.

By applying a suitable canonical transformation to a system consisting of nuclear particles and a meson field, and by assuming an interaction between the meson field and electrons and neutrinos, Dr. C. Møller and Prof. L. Rosenfeld arrive at a transformed Hamiltonian containing a term which gives the probabilities of beta-disintegration processes. The introduction of a pseudoscalar wave function, in addition to the four-vector one, offers the possibility of a better adaptation to the experimental results.

Dr. Harold Jeffreys, in reply to Dr. W. Edwards Deming, maintains that the notion of reasonable degree of belief is implicit in every application of the theory of probability, and that the frequency definition, though designed to avoid this notion, in fact fails to do so in actual application.

Commenting on Prof. Coleman's contention that the late Palæozoic glacials of the southern hemisphere would have necessitated the presence of relatively warm seas in the neighbourhood, Dr. A. L. du Toit states that conditions of oceanic and atmospheric circulation and solar radiation are more important for the formation of an extensive ice-cap than nearness to warm water, and that the hypothesis of a south polar drift of the Permo-Carboniferous Gondwanaland is not invalidated.

Prof. E. V. Appleton and R. Naismith describe the reception of a medium-delay radio echo at Tromsø during the International Polar Year 1932–33, under ionospheric conditions such that it was possible to interpret the results as due to lateral scattering from a complex ionized centre at a considerable distance, and not to reflection at a very great height above the ground.

Dr. J. A. Chalmers and E. W. R. Little report a measurement of an average precipitation current for a period of ten minutes of more than $-7{\cdot}3 \times 10^{-12}$ amp./cm.^{2}, during a shower of soft hail. This exceeds the vertical fine-weather current for a whole year.

Prof. L. Farkas and A. Farkas find a fairly rapid rate of exchange between the hydrogen atoms in the molecule of hexane (or cyclohexane) and deuterium, when a gaseous mixture of the two is brought in contact with platinized platinum foil.

In experiments on the growth of young rats fed on two varieties of rice, adjusted to the same protein content, but differing widely in regard to their phosphorus contents, Dr. A. Sreenivasan finds that the growth rate is greater with the variety of rice containing the larger percentage of phosphorus.

A variety of *Œnothera missouriensis* grown at the Courtauld Laboratory, Regent's Park, London, has been found to be sterile when self-pollinated. The plant has seven free pairs of chromosomes, and Prof. R. R. Gates suggests that it has developed a mechanism of self-sterility in order to maintain a heterozygous condition.

By immersing seeds of chilli (*Capsicum annum*) in solutions of colchicine of various concentrations, Drs. B. P. Pal and Dr. S. Ramanujam have obtained plants with increased number of chromosomes (tetraploids and one triploid) showing abnormality of growth (thicker leaves, fasciation of stem, doubling of flowers).

Dr. Lucius Nicholls records the mating of a pair of lorises in captivity. They had been caught in the hills of Ceylon at a height of between 5,000 ft. and 6,000 ft. They made a curious chewing sound whilst mating. A living young one was born 174 days after mating had taken place.

Research Items

Diet of Serbian Gypsies

IN Serbia it is known that gypsies feed on carrion, and a number of instances of their addiction to the flesh of animals, which have not been slain for food, but have died a natural death or from disease, have been collected by Dr. Alexander Petrovič in a further contribution to his studies of the gypsies of Serbia (*J. Gypsy Lore Soc.*, Ser. 3, **18**, 1; 1939). This is a matter of preference, as it occurs even among the more well-to-do. Mirijevo, a village near Belgrade, where there are some twenty gypsy families whose material condition is comparatively good, is renowned for the fact that its gypsies eat carrion. When a peasant has a sow or hog or an ox that has died of some disease, he buries it in a piece of ground near the road. Someone will then inform the gypsies of the fact, and they will pay a small sum for the information. Then at night two or three will go to the spot indicated, dig up the carcass, and carry it home. At Rakovica, also near Belgrade, when there was a serious pestilence among the sheep in 1937 the peasants were at their wits' end to know what they should do with the dead sheep. Some were buried, others thrown into the fields and meadows. Gypsies from Ripanj, an outlying village, used to come at night, dig up the carcasses, and carry them away. Dead horses are also dug up and their hides, and sometimes the meat as well, are sold; but a gypsy never eats horseflesh, because the horse is a friend of the gypsies and is considered more or less a member of the family. Some of the poorer gypsies eat carrion meat without special preparation; but others prepare it by washing, soaking with nettles or garlic, and boiling until the smell has gone. Sedentary gypsies eat carrion meat only when with gypsies who prepare it in this way. It is then said, however, to be tasteless; while those who express preference for the flesh of animals that have died, say that it is on account of its flavour, which is superior to that of slain meat. Whether the sense of smell among gypsies is deficient is neither clear nor easy to ascertain. Their vocabulary, though not decisive one way or the other, suggests that they do not discriminate very decidedly between smells, good or bad.

Race, Religion and Caste in India

IN the course of a study of the racial affiliations of religion and caste in India, Rai Bahadur Sarat Chandra Roy considers the probable contribution to the formation of caste of the Alpine and Mongol racial elements in the population (*Man in India*, **18**, 2–3, 1938). One section of the Alpines appears to have entered India by way of the Pamir plateau and the Hindu Kush in the Chalcolithic period. At the present time the modern Asiatic representatives of the race are found in this region in their greatest purity, and the race is also the dominant element in the Khotanese. Neither among these nor among the European Alpines is there found anything resembling the caste system as it is known in India. In central Asia this is not due to the influence of Islam; for the Tafiks of Kashgar, for example, retain customs and beliefs derived from Pre-Islamic times, which are not approved by Islam. Even class sentiment neither determines occupation nor prevents intermarriage between different social grades. Among European Alpines, tribal feeling is still, or was until recently, strong among Balleon peoples; and some have bird names. There is also evidence of bird names among the people of Bengal and the Prabhus of Bombay Presidency, who contain a strong brachycephalic element. In comparatively early times Aryans visiting famous places of pilgrimage in Bengal, Gujarat, Anga and Kalinga, presumably of Alpine or pre-Aryan origin, were required to undergo an expiatory ceremony. Although Indian representatives of the Alpines, such as the Bengalis, Gujrātis and Mārātas have long adopted the Hindu caste system, they are not as rigid in observance as, for example, the Dravidian Hindus of the south. Buddhism with its doctrine of equality was especially strong in Bengal and among Gujrātis, as also were Vaishnavism and Jainism. The first historical king of Bengal, Gopala Deva, was elected by the people, and the Mārātas have an equally democratic spirit. Modern movements for social and religious reform have been initiated and developed for the most part by men of the Indo-Alpine race; but they appear to have contributed little to the formation of the complex caste system.

Growth of Tissues *in Vitro*

O. A. TROWELL and E. N. WILLMER (*J. Exp. Biol.*, **16**, 60; 1939) made tissue extracts from several organs of growing and adult fowls and tested the growth-promoting properties of these extracts on periosteal fibroblasts growing ***in vitro***. They found that these properties were most pronounced in brain extract and diminished in the following sequence—thyroid, thymus, testis, ovary, bone-marrow, liver, kidney and muscle extracts. Extracts made from the spleens of adult cocks were far more efficient growth-promoting agents than extracts made from the spleen of young birds. The growth-promoting power of a tissue extract could not always be correlated with the age of the tissue from which the extract was made, with the rate of growth of that tissue or with its nuclear content.

Rat Fleas in Plymouth

R. B. MAYFIELD (*Parasitology*, **30**, 314; 1938) investigated the species and numbers of fleas harboured by rats in a certain section of the Plymouth docks, and also examined a few rats from the town of Plymouth. The total number of rats investigated was 83. Of 77 rats caught in the dock premises, 63 were examples of ***Rattus norvegicus*** and 14 of ***Rattus rattus*** which were found to harbour three species of fleas, namely, ***Nosopsyllus* (*Ceratophyllus*) *fasciatus***, ***Xenopsylla cheopis*** and ***Leptopsylla segnis* (*musculi*)**. The presence of ***Xenopsylla cheopis*** was almost entirely confined to a certain grain store. Four specimens of ***Rattus norvegicus*** and two of ***Rattus rattus*** were caught in the town of Plymouth and yielded 32 specimens of ***Nosopsyllus fasciatus*** and 3 of ***Leptopsyllus segnis*** but no ***Xenopsylla cheopis***.

Bird Fauna of a Rocky Island

THE aptitude of some animals to make use of the most unpromising conditions is shown by a short account of the birds of Malpelo Island by James Bond and Randolphe Meyer de Schauensee (*Proc. Acad. Nat. Sci. Philadelphia*, **90**, 155; 1938). The island is a bleak pinnacle of volcanic rock, 330 miles from the mainland of Columbia; the upper plateau presents "one of the most barren, bleak expanses of rock I have ever seen. Not a single plant living or dead was to be found", says one of the authors; the only vegetation the survey revealed was on a steep cliff about 200 ft. high, where there was a moss and a grass growing from the damp crevices. Yet here was found a small fauna of ten species of birds. Most of them were sea-birds, which depended upon the surrounding ocean to supply them with food—a booby, a small colony of frigate birds, a colony of thirty gulls, and two species of terns. But there were waders, ten spotted sandpipers in company with about twenty-five wandering tattlers (*Heteroscelus incanus*), a duck hawk, and more remarkable still, a martin (*Progne* sp.) and barn swallows which were apparently inhabiting a cave. The latter birds must have been subsisting upon some sort of insect life; it would be of great interest to know the complete fauna of this isolated and barren island. The visit was made on February 8, 1937.

Census of Californian Sea-Lions

COMPLAINTS have been made by commercial and sport fishermen that the sea-lions of California cause inordinate damage to fish stocks and to fishing gear, and that the destruction is increasing with a numerical increase in the seal colonies. It was thought possible that the Californian population had been increased on account of the migration northwards of Mexican individuals, following upon the activities of a company engaged there in killing and canning seal flesh for cat and dog food. To test these suppositions, a census of the seal rookeries was carried out between June 13 and 26, 1938 (*California Fish and Game*, **24**, 415; 1938). This census did not reveal any great change in the sea-lion population. During the last census, in 1936, Steller's sea-lion (*Eumetopias stelleri*) had a total population of 4,900, in 1938 it was 5,841; while the corresponding figures for the other species, the Californian sea-lion (*Zalophus californianus*) were 2,501 and 2,020. Indeed, the five counts carried out from 1927 to 1938 show that the sea-lions have remained about the same numerical level, for although the trimming hunters have ceased to kill the adult bulls and the State law protects the animals, a good many are still slaughtered annually by 'sportsmen' and fishermen. Natural mortality is heavy, not more than 50 per cent of any year's crop of pups reaching the age of one year, while the death-rate amongst adults is also comparatively high; so that the present birth-rate seems about to balance the death-rate. The conclusion of the authors, Paul Bonnot, G. H. Clark and S. Ross Hatton, is that for the present there seems to be no reason for reducing their numbers.

Host Selection in a Chalcid Wasp

D. C. LLOYD, of the Farnham House Laboratory, Imperial Institute of Entomology, describes his attempts to determine those factors that are involved in the selection of hosts by the chalcid *Ooencyrtus kuvanæ* (How.) (*Phil. Trans. Roy. Soc.*, B, **227**, Dec. 1938). He also describes observations made on the distribution of the eggs in a restricted environment (Petri dishes) such as when the chalcid is kept in immediate contact with the host (eggs of the gypsy moth) in which it lays its eggs. It is shown that egg-laying by this parasite is not at random but has reference to the nature of the host available. Usually the female selects unparasitized hosts. If she is forced to superparasitize, she selects those host-eggs containing the youngest parasites. If only parasitized hosts are available the female parasites tend to retain their eggs rather than deposit them. It is concluded that the oviposition response is to a perceptual complex of stimuli which is such that the female insect tends to select those hosts in which the progeny are able to develop.

Post-Glacial History of Fenland Vegetation

A SERIES of sections and bores throughout southern Fenland show a stratigraphical sequence of lower peat, fen clay and upper peat to occur regularly over the entire area. Past ecological and climatic changes reflected in this succession have formed the subject of an investigation by H. Godwin and M. H. Clifford (*Phil. Trans. Roy. Soc.*, B, **229**; Dec. 1938). Tree remains are abundant in the lower peat. At Woodwalton Fen this peat formation apparently led to the destruction of pre-existing oakwoods on clay giving rise to, at first, open water or alder brushwood, passing gradually into drier fen woods with oak, birch and pine. The clay bed separating the peats is shown by foraminiferal and diatom analysis to have been laid down in brackish water and hence represents a marine transgression. A freshwater phase developed later with extensive development of *Sphagnum-Eriophorum-Calluna* peat and the formation of raised bogs which were locally submerged later by the formation of meres in which calcareous lake marl was deposited over the acidic *Sphagnum* peat. The correlation of the vegetation phases with archæological and climatic horizons leads the authors to date the general formation of peat in the fens in the Atlantic period. They became wooded in the Neolithic period and the marine transgression which gave rise to the fen clay occurred at the end of the Neolithic period. The raised bogs were developed during the Bronze and Iron Ages. A second marine transgression occurred in Romano-British times. This gave rise to a layer of semi-marine silt which overlies the upper peat on the seaward side of the fens and along the courses of the estuaries. There were human settlements upon the silt whilst it was forming, and its present surface shows the remains of dense occupation. The great meres of the Fenland probably formed either in the Iron Age or the Romano-British period.

Greenland Plankton

THE Godthaab Expedition visited the waters west of Greenland in 1928, and extensive plankton samples were taken and associated with hydrographic work. The collector, Gunnar Seidenfaden, gives an account of the work of collecting, and his experience of the inadequacies of his equipment should be of value for guidance of future expeditions. The material collected has been worked over and described by

Jul. Grøntved, who has collaborated with Seidenfaden in the account of the distribution of plankton (*Meddelelser om Grønland*, **82**; 1938). Previous records of plankton from 1850 onwards for the region are discussed and incorporated in the distribution maps for the species, now greatly extended through this expedition, especially in the more northern waters, and this volume forms an extremely useful basis, upon which more detailed knowledge may be built up. The samples include surface collections, and a considerable number of depth samples, especially down to about 100 m.; the species fall mainly into the groups Diatomeæ, Peridineæ, Flagellatæ, Ciliatæ. (Chlorophyceæ were not observed in the material.) The Grinnell Expedition, 1850–51, collected a sample of 'red snow', and it is of interest that this appears to have been from Crimson Cliff, near Cape York, which again on this present expedition showed the same phenomenon. This well-known locality for 'red snow' is due to perennating snow flats, near bird-cliffs, which supply the nutriment for the organism.

Moisture in Wood

A BROCHURE entitled "Recent Work on Moisture in Wood" by W. W. Barkas, issued for the Forest Products Research Laboratory (H.M. Stationery Office, 1938), summarizes the results of recent research undertaken by the Physics Section. The objects of the study were the mode of retention of water by wood, and the part which this water plays in determining the strength and shrinkage of the material. The main conclusions arrived at are (1) the differentiation between the molecular and capillary water held in the cell wall, (2) the demonstration that the water in the cell cavities cannot be sharply differentiated from the capillary water in the cell walls, (3) the proof that strength, shrinkage and vapour pressure changes begin in the wood as soon as it is dried below the waterlogged moisture content, (4) the evidence put forward that wood reacts identically under externally applied loads and under internal shrinkage forces.

Clover Creek Earthquake of July 15, 1938

THIS earthquake was worthy of particular study by H. Landsberg (*Bull. Seis. Soc. Amer.*, **28**, No. 4, Oct. 1938) since earthquakes in the Appalachian region of the United States are singularly infrequent. The shock occurred at 5.45 p.m. E.S.T. (22.45 G.C.T.) in Pennsylvania in an area known as Morrison's Cove, a limestone valley between the Tussey Mountains in the east and the Dunning, Short, Loop, and Lock Mountains in the west; in the north the boundary is the Juniata River. The shock was not recorded by seismographs and was probably tectonic in origin, though a 'cave-in' is not an impossible hypothesis. From macroseismic evidence collected by the author and the U.S. Coast and Geodetic Survey, the author was able to construct a map and indicate intensities on the modified Mercalli scale, thus making the epicentre known. For the purpose of estimating the focal depth, H. Neuberger (*ibid.*, p. 259) developed the new formula

$$h = \frac{sR_n^2}{4{\cdot}6 \log \frac{I_e}{I_n}} - \frac{1{\cdot}15}{s} \log \frac{I_e}{I_n}$$

where h is the depth of focus in kilometres; s an absorption coefficient; R_n the radius of an area within an isoseist n; I_e the Mercalli intensity of the shock in the epicentre; I_n the Mercalli intensity at the isoseist n. Microseismically in the district in question $S = 0{\cdot}1$, and hence the focal depth was between 0 and 7·5 km.

Oxidation of Carbon Disulphide

IN a study of the non-explosive catalytic oxidation of carbon disulphide vapour in dilute mixture with air, R. H. Griffith and S. G. Hill (*J. Chem. Soc.*, 2037; 1938) made the interesting observation that at about 140° in the glass tube oxidation occurred with simultaneous production of ozone. This is probably due to the presence of atomic oxygen. The yield is fairly small, about 0·5 mgm. of ozone per hour with 65 mgm. of carbon disulphide; but the ozone can be detected by the smell and gives characteristic reactions. This homogeneous reaction is difficult to suppress, but this can be done by adding small amounts of ethylene, when the heterogeneous reaction with nickel sulphide as catalyst can be followed and is found to be of zero order with respect to carbon disulphide. Carbonyl sulphide (COS) was also studied and was found not to undergo homogeneous oxidation so readily and no difficulty was found in following the heterogeneous reaction alone, which was found to be of the first order with respect to carbonyl sulphide but to be retarded by sulphur dioxide. The same authors have previously (*J. Chem. Soc.*, 717; 1938) described the preparation of the catalyst of nickel subsulphide, Ni_3S_2, from finely divided metallic nickel by the action of carbon disulphide vapour carried in nitrogen at 350°, and have investigated its use in the catalytic hydrogenation of carbon disulphide, carbonyl sulphide, mercaptan and sulphur dioxide, the work being extended by B. Crawley and R. H. Griffith (*J. Chem. Soc.*, 720; 1938).

Nuclear Physics

THE issue of the *Review of Scientific Instruments* of December 1938 devotes eighteen pages of its Physics Forum to a review of progress during the past year by T. H. Osgood of the University of Toledo, Ohio. In the section devoted to nuclear physics the author shows how the study of the products of the bombardment of elements by fast neutrons has led to the discovery of isomeric forms of the same nucleus and he points out the value of the "evaporation" theory of the nucleus, according to which an energetic particle injected into the nucleus shares its energy rapidly amongst the components of the nucleus, which remains in an excited state until a chance accession of energy by a particle leads to its evaporation from the nucleus. Progress in mapping energy-levels has been facilitated by the study of resonance effects when the injected particle has some particular energy. The production of controlled beams of particles has been assisted by placing the electrostatic generators in air at 6 or 7 atmospheres and in this way producing several million volts in a small space. Important results are expected from the new method of producing slow neutrons by the intermittent action of cyclotrons, particularly when the number of instruments is increased by the completion of those now under construction in various centres.

Isotopes of the Alkaline Earth Metals from Uranium

DURING the last two years, the bombardment of uranium by neutrons has led to some striking results, due primarily to the combined efforts of Prof. O. Hahn, L. Meitner and F. Strassmann, working in the Kaiser Wilhelm Institute of Chemistry in Berlin-Dahlem. In addition to *three* artificial isotopes of uranium, they have succeeded in establishing the existence of *six* trans-uranium elements of atomic numbers 93–96, and the existence of a seventh trans-uranium element (half-value period = 60 days) is indicated.

In similar experiments, I. Curie and P. Savitch obtained evidence of the production of a substance with a half-value period of 3½ hours. The identity of this substance is uncertain, and although the authors have considered several possibilities, none of them is very satisfactory. Recent experiments on the chemical properties of the trans-uranium elements have led O. Hahn and F. Strassmann (*Naturwissenschaften*, **26**, 755, Nov. 18, 1938; and **27**, 11, Jan. 6, 1939) to look for this substance (half-value period = 3½ hours), and they have been successful in obtaining it by the same methods as those used by the French workers. Their investigations have led to remarkable results which are summarized in what follows.

The bombardment of uranium with neutrons apparently resulted in the production of *four isomeric isotopes of 'radium'*, which must have arisen by two successive α-ray transformations via thorium. These four 'radium' isotopes emit β-rays and yield four isomeric isotopes of 'actinium', which, in their turn, by further emission of β-rays, presumably give rise to four isotopes of 'thorium', but details of these last products are still incompletely known. The results so far obtained may be represented provisionally by the following scheme, in which the nature of the radiations emitted and the revised half-value periods of the new products are indicated.

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{239}_{92}U \xrightarrow{\alpha} {}^{235}_{90}Th \xrightarrow{\alpha}$$

'Ra_i' ? $\xrightarrow{\beta}$ (< 1 m.) 'Ac_i' $\xrightarrow{\beta}$ (< 30 m.) 'Th' ?

'Ra_{ii}' $\xrightarrow{\beta}$ (14 ± 2 m.) 'Ac_{ii}' $\xrightarrow{\beta}$ (c. 2·5h.) 'Th' ?

'Ra_{iii}' $\xrightarrow{\beta}$ (86 ± 6m.) 'Ac_{iii}' $\xrightarrow{\beta}$ (sev. days?) 'Th' ?

'Ra_{iv}' $\xrightarrow{\beta}$ (250-300h.) 'Ac_{iv}' $\xrightarrow{\beta}$ (< 40 h.) 'Th' ?

Should this scheme adequately represent the facts, these twelve new substances should have atomic weights of value 231, and since a natural thorium isotope (UY) of atomic weight 231 and half-value period 25 hours is already known, it will be of interest to investigate whether one of the four 'thorium' isotopes is identical with UY.

Hahn and Strassmann believe that the substance found by Curie and Savitch is a mixture of the above-mentioned isotopes, each of which has been individually detected and chemically examined. Moreover, the properties of such a mixture would agree with those of the substance detected by the latter authors, who suspect that their substance also contains others of longer life, but of unknown genesis.

An interesting feature of this work is that the production of the new isotopes is enhanced by the use of *slow* neutrons, and the α-particle disintegrations indicated in the earlier stages of the process are believed to be the first instances of α-particle emission effected by *slow* neutrons. It is, of course, possible that the quadruplicity of isotopes resulting from the bombardment of uranium by neutrons takes place in $^{239}_{92}U$, as in the case of the trans-uranium elements, and the intermediate 'thorium' isotope $^{235}_{90}Th$ may also possess four half-value periods.

In the second of their publications mentioned above, Hahn and Strassmann give particulars of the chemical methods employed in establishing their results, as well as a number of activity curves from which some of the half-value periods have been derived. In order to establish beyond question the chemical nature of the products they have designated 'radium' isotopes, which were separated with barium, the authors carried out fractional crystallizations and precipitations with the active barium salts, by the method used for altering the concentration of radium in salts of barium containing radium.

As is well known, crystals richer in radium can be obtained by fractional crystallization of the chloride, bromide or chromate of barium, when it contains radium. In experiments on these lines, carried out by Hahn and Strassmann with their active barium preparations from which disintegration products had been removed, negative results were always obtained, that is, the activity was uniformly distributed amongst the various barium fractions, whereas control experiments with barium containing the radium isotopes ThX and $MsTh_1$ yielded results conforming to those obtained when the barium contains ordinary radium. In a further experiment, in which 'Ra_{iv}' and $MsTh_1$ were mixed with barium and then subjected to fractional crystallization, only the $MsTh_1$ was concentrated in the process.

The authors conclude from these results that their 'radium' isotopes have the properties of barium, and that, from the chemical point of view, other elements being excluded, these active substances must be regarded as consisting not of radium but of *barium*. This conclusion has been confirmed by further indicator experiments, according to a personal communication from one of the authors (O.H.).

Hahn and Strassmann have also subjected a mixture of their 'Ac_{ii}' and the actinium isotope $MsTh_2$ with lanthanum oxalate to fractionation from a nitric acid solution. At the end of the process a gain in concentration of $MsTh_2$ was achieved, but no increase in the concentration of 'Ac_{ii}' was noted. From this they conclude that the substances generated by β-ray emission from their alkaline-earth products are not isotopes of actinium, a conclusion which agrees with that of Curie and Savitch for their composite product of half-value period 3½ hours. In all probability they will prove to be isotopes of *lanthanum*. The products designated 'Th' in the above scheme of disintegration, which constitute the final members of the series

derived from the 'Ac-La' preparations, have not yet been tested for their identity with *cerium*.

On the strength of the chemical evidence, it is difficult to avoid the conclusion that the elements denoted by the symbol 'Ra' in the above-mentioned disintegration scheme should in reality be designated 'Ba', and so far as the evidence has gone it seems probable that the succeeding elements 'Ac' and 'Th' will prove to be 'La' and 'Ce' respectively. It is as though, at some stage in the process resulting from the bombardment of uranium by neutrons, a 'collapse' of the nucleus occurs, giving rise to the four active isomeric alkaline-earth elements and the succeeding 'lanthanum' and 'cerium' products. The investigations are being continued. R. W. L.

Subspecies and Varieties

A DISCUSSION dealing with subspecies and varieties was held at the meeting of the Linnean Society on February 2. This discussion had been arranged at the request of the Association for the Study of Systematics in Relation to General Biology in order to obtain information as to the views and principles governing the practice of systematists in various groups of animals and plants. It was apparent from the discussion that systematists are generally dissatisfied with the existing state of affairs. As was to be expected, little or no attention is paid to infra-specific categories in the less-known groups of both plant and animal kingdoms; but where the broader taxonomic outlines are well understood there is considerable divergence in systematic practices according to the amount of genetical, cytological and ecological work that has been done. In vertebrates, only a single infra-specific category, the 'subspecies', is generally recognized, but in entomology and botany there are others. How many there may be and their status in the taxonomic scheme are matters of dispute, and there is a disturbing confusion in the terminology applied to them. In this connexion, it may be mentioned that the Association is compiling a list of the various terms which have been used. Almost all the speakers stressed the need for more experimental work from the genetical, cytological, physiological and ecological aspects.

In opening the discussion, Mr. M. A. C. Hinton described the practice of mammalogists, who, in recent years, have used the term 'subspecies' to express stages or trends in geographical variation; they are sections of what Dr. Julian Huxley has called 'clines' (NATURE, **142**, 219; 1938). One principle generally accepted is that no two races of the same species can ever be found on the same ground, though exceptionally two such forms may meet after very different histories and journeys and continue to exist side by side without fusing. The principle that, unless intergradation can be demonstrated, differences, however trivial, indicate specific separation, has some theoretical support. In practice, however, it has disadvantages, especially in dealing with insular forms, and tends to mask that most interesting and instructive phenomenon, discontinuous distribution.

The definition of subspecies is an essential part of any intensive analysis of the facts of variation and distribution, and is particularly valuable in palæontology, by preventing loose identifications and consequent faulty geological deductions. It is hoped soon to commence large-scale experiments to test the values and permanence of subspecific characters and to obtain more definite information on subjects concerning which surmise alone is at present possible.

Dr. W. B. Turrill emphasized that all taxonomic categories are matters of scientific convenience based on abstractions from a continuous evolution. He recognizes that for little-known floras it is undesirable to analyse below the species level; but urged that in relatively well-studied floras the need is for intensive studies of infra-specific variation from every angle. His own researches have led him to the conclusion that taxonomic categories intergrade completely. He suggested that the term 'variety' should be used for every phenotype which is the expression of a different genotype, and that the term subspecies should be used only when a species is in process of breaking up into new ones. Names should be given to infra-specific groups only to serve some definite purpose, and in highly polymorphic species symbols might be used instead. Apomicts should receive distinct treatment.

Mr. A. J. Wilmott pointed out that confusion results from using the words species, subspecies and variety both for categories of variation in Nature and groups of different rank in the nomenclatural system. He suggested that the terms 'binome' and 'trinome' might be substituted for species and subspecies in the nomenclatural sense, leaving the latter free for application to categories of variation. True subspecies are parts of the present time section of a lineage which has become branched by isolation, but the branches of which are not yet completely separated. Varieties, on the other hand, are in a different category, being merely the observed phenotypic effects of separate genes, and not different *kinds* of organisms; they should not be given names under the same system as species and subspecies, but might be designated by symbols.

Mr. J. S. L. Gilmour dealt with the philosophical aspect of the subject and drew a distinction between taxonomic and non-taxonomic infra-specific categories. The former, which might be limited to subspecies, variety, and form, should be based so far as possible on the total attributes of the individuals concerned, while the latter should be based on a selection of attributes chosen for special purposes. Examples of such non-taxonomic categories are Dancer's 'commiscuum', 'comparium', and 'convivium', based on interfertility data, and useful for investigating the relationship between such data and other attributes, such as morphological differentiation. He urged that this distinction is essential for the proper classification of infra-specific variability.

Mr. H. W. Parker showed that the practice of herpetologists is essentially similar to that of mammalogists. He believes, however, that owing to lack of other data, systematists have laid undue emphasis on geographical considerations, with invidious results. Recognition by trinomials of certain forms to the

exclusion of others equally important, and the inclusion of different grades of infra-specific rank, in the same category is misleading. The traditional methods employed in taxonomy must be supplemented for the study of infra-specific variations, and not until we know more of the categories to be dealt with can a satisfactory scheme of nomenclature be devised.

Dr. B. P. Uvarov expressed his belief that the recognition by entomologists of subspecies, in the sense of geographical races, has been of great practical convenience; it has enabled taxonomists to unite numerous minor forms into large species without losing sight of their individuality. Recent physiological, ecological and genetical work has revealed the existence of races which are indistinguishable by external characters. Between these incipient, deeply seated, internal changes and the appearance of external morphological characters there is probably a time lag; consequently even the smallest external differences, if not irregular and obviously casual, deserve the closest attention as representing quite an advanced stage in variation.

Prof. McClung remarked that the perfect taxonomy has been described as the summation of all biological knowledge; we have obviously not yet reached perfection and the present discontent shows a striving in the right direction.

Mr. C. E. Hubbard said that the terms subspecies and variety are used by systematic botanists to cover every grade from a slight variation in one character to a well-defined species. In the floras of large tropical areas there occur numerous polymorphic species which, in the absence of detailed knowledge, it seems best to lump together and note the polymorphism. Where variations are of economic importance, those that are well defined can be given binary names with the view of making reference easier.

Prof. F. E. Weiss agreed with the previous speakers that investigations of the taxonomic categories need further biological knowledge, especially genetical. Frequently genetical analysis can establish the status of a taxonomic group when the systematist is in doubt. A good example is seen in the pimpernels; of the two blue forms, one has proved to be a genetically stable species and the other, scarcely distinguishable by any other criteria, merely a mutation of the red species.

Dr. Julian Huxley emphasized that taxonomy deals with natural groups having a real existence. Discussing infra-specific variability, he pointed out that in the gradation between varieties, subspecies and species, the points of stability are more frequent than the intergrading zones. He dealt with various causes of discontinuity and mentioned especially isolation leading to non-adaptive variation, and the production of partial discontinuity by the formation of internally stable gene-complexes. For the description of more or less continuous variation he suggested the use of his 'cline' concept.

Dr. R. Melville pointed out that hybridization is much commoner in plants than in animals and that in certain groups the species can be arranged on an intergrading series corresponding to a 'cline' in Huxley's sense, but with no geographical basis. He suggested that new terminology should be used for forms constituting these series.

Prof. W. Garstang commented on the difficulties of genetical research on animals, and directed attention to the existence of 'clines' in fishes, particularly herrings and mackerel. In some instances, the 'clines' can be correlated with gradual environmental changes.

Interstellar Space

ON May 13, 1938, Prof. Charles Fabry delivered the George Darwin Lecture at the Royal Astronomical Society and dealt with the problem of the nature of the matter which exists in interstellar space (*Mon. Not. Roy. Astro. Soc.*, **98**, 9, Supp. No., October 1938). The subject is so vast that it was possible for Prof. Fabry only to review briefly the different methods of investigation and the interpretation which has been placed upon what they reveal. As is well known, the Doppler effect has enabled the interstellar lines to be detected. The displacement of the lines in stellar spectra gives the radial velocity and this should be the same for all lines. If a line gives a velocity which differs from that derived from the displacements of other lines, the discrepancy must be due to matter situated between the star and ourselves—in other words, interstellar matter. In 1904, Hartmann observed the spectrum of δ Orionis, a star of variable radial velocity, and found that the velocity, measured on the hydrogen lines, varied between + 133 and − 66 km./sec., but the lines of ionized calcium showed a constant velocity of + 16 km./sec. This supplied the evidence for the existence of a cloud of ionized calcium between the star and ourselves. It seems remarkable that for fifteen years these ionized calcium lines were the only ones which were known with any certainty. In 1919, however, Miss Heger established without doubt the existence of neutral lines of sodium, and with improvements in spectroscopic methods more interstellar lines have been discovered. It is interesting to notice that the exploration of the ultra-violet lines of sodium by Adams and Dunham has been rendered possible by the use of aluminized mirrors and of gratings ruled on an aluminized layer. The discovery of other lines which cannot be identified has caused some speculation regarding their origin, and Prof. Fabry conjectures that microscopic crystals, perhaps giving absorption bands at the very low temperature, may be responsible for some of them.

Among some of the interesting results accomplished may be mentioned the estimate of the mean radial velocity of the interstellar matter between the star and ourselves, and it seems that the interstellar gas has the same mean rotation as the galaxy. Quite recently, however, Beals has shown that in some cases it is possible to detect masses of interposed gas which have different velocities. Important developments may be expected in this particular sphere.

It is impossible in the limited space to refer to more than a few of the points dealt with in the lecture.

One matter of some interest may be mentioned in conclusion. Cabannes and Dufay found in the light of the night sky a yellow line which they suspected to be sodium, and during the present year they have been able to show conclusively that sodium lines are present. Bernard showed that this sodium doublet is emitted by the very high layers of the atmosphere, the line being greatly intensified at twilight when the upper atmosphere is illuminated by the sun. What is the origin of this sodium? Does it come from the earth where small crystals of sodium chloride exist in abundance, or is it interstellar sodium which the earth has picked up in its journey through space? How are the sodium atoms excited? Perhaps solar radiation may be able to produce this excitation, but this, like the other points, cannot be answered at the moment, and we must await future research for light on the subject.

Non-astronomers will find much of the lecture readable and they will be amply repaid for the time spent on studying the numerous matters of interest dealt with by Prof. Fabry.

H. T. de la Beche: Geologist and Business Man

By Dr. F. J. North, National Museum of Wales

FEBRUARY 16, 1839, was an important date in the history of the Geological Survey, for on that day Mr. (as he was then) H. T. de la Beche wrote a letter which eventually resulted in the Survey being changed from a one-man affair, with no settled headquarters, to a great organization with an office in London*. It was something to have persuaded the Government to make a grant of £300 for the purpose of colouring geologically a few sheets of the Ordnance Survey map, but a geological survey of the whole of England and Wales was quite another matter, and, like Oliver Twist, de la Beche was continually asking for more—money for instruments, a travelling allowance, and permission to extend the survey into other parts of the country. He was not only able to envisage a National Geological Survey but he had also the courage and perseverance to overcome official inertia in order to establish it.

It is the object of this note to illustrate, by reference to one of his campaigns for the expansion of his work, the kind of man he was and the debt which geology owes to him. It is based upon de la Beche manuscripts deposited by the late Colonel J. I. D. Nicholl in the Geological Department of the National Museum of Wales, and upon some old letter books of the Ordnance Survey, to which, by kind permission of the Director, I was given access.

When the geological mapping which de la Beche had been allowed to undertake in Devon, Cornwall and Somerset was nearing completion, he obtained permission to continue the survey in South Wales, where he found a willing voluntary collaborator in W. E. Logan, then a young man engaged in the copper smelting business, and also received help in the field from one of the Ordnance surveyors, Henry McLauchlan. This help was, however, local and occasional, and arguing that, on the basis of his work in Devon, he could not hope to cover the whole of England and Wales in less than twenty-one years, de la Beche decided to seek permission to secure constant assistance with the view of completing the map in about ten years, and in a letter to Colonel Colby, the director of the Ordnance Survey (February 16, 1839), he wrote:

"It being an object of importance that the Geological Survey should be rendered as efficient as the money granted for the service will permit, . . . I would respectfully suggest for the consideration of the Honourable Board of Ordnance that I should be permitted to hire such Geological Assistants as I may consider requisite for the proper execution of the work . . . such geological assistants to be chosen by myself and discharged by myself as may in my judgment appear reasonable and proper. . . . I would propose that I should not award any rates of pay exceeding ten shillings per day without special authority from the Honourable Board, and that I should send a quarterly return for the Honourable Board's information, showing the names and rates of pay of the persons so employed."

During the previous five years many letters concerning finance had passed between de la Beche and his employers, and his new application shows that he had profited by his experience. His opening remarks related to efficiency and economy, in his conclusion he disarmed criticism by offering to lay all his cards upon the table, whilst a condition that he knew from experience would be one of vital importance was inconspicuously inserted in the middle.

As usual, the Inspector General of Fortifications was cautious, and he endorsed the application as follows: "I know of no authority for the extensive view here taken of extending the Geological Research beyond the eight sheets of the Ordnance Survey authorized by the Master General's and Board's order of the 2nd May, 1832, and I should beg to submit the expediency of not proceeding . . . until something like an approximate estimate of the whole intended outlay be submitted to Parliament in the usual way."

The result of this endorsement was a letter to Colby stating that "The Master General and the Board are decidedly of opinion that it will never do to go on with this Geological Survey without some distinct rules by which the expense is to be governed. They are desirous of affording Mr. de la Beche every facility, but it must be on some express understanding as to the extent of work to be executed, and the length of time to be occupied. By reference to the original arrangement it will be seen that a most material departure has already taken place from what was then proposed, and . . . what is now asked for will lead to an unlimited expenditure of time and money."

De la Beche was asked to indicate how long the whole work would take, and how much it would cost,

* A brief account of the early history of the Geological Survey was given by Sir John Flett in "The First Hundred Years of the Geological Survey of Great Britain" (1937), which was reviewed in NATURE of November 27, 1937.

and in reply he explained that it was not possible to estimate "the cost of Geological Surveys and the time necessary for their completion, as until some examination of a given area has been effected no correct idea of the whole expenditure can be formed". The region then under consideration was South Wales, and, he continued, "The coal and iron districts require great care both in scientific and economic points of view, and hence far more time has to be bestowed upon them, than upon most other portions of the country . . . but perhaps thrown in with South Wales generally the whole may be taken at about £1 per square mile".

Colby also replied to the Board, pointing out that the letter which he had received "contains no reply whatever to the original question of Mr. De la Beche being permitted to hire assistants", and stating that he (Colby) had realized the necessity for hiring assistants during the progress of the work in Devonshire.

Careful handling of the situation eventually resulted in an official acknowledgment that it was not possible to foresee and to legislate for every contingency that was likely to arise during the course of a geological survey, and on March 15 it was reported that, "The Master General and Board consider the explanation given to be so far satisfactory as that it limits his labours to the completion of certain parts of the Survey for which the authority of the Treasury has been obtained, and to this he must be confined until the Master General and Board receive further instructions on the subject. With respect to the expenditure, the only plan . . . will be, from year to year, to take such a sum as may be deemed advisable, upon which point the Master General and Board would from time to time avail themselves of your opinion and so check any extraordinary expense that may be proposed".

De la Beche was quick to act upon the recommendation, for in April he wrote, in a letter to Colby: "I have picked up one very clever hand as an assistant at 7*s.* per day, a regular good one he is, and I am now on the look out for others". The "regular good one" was David Hiram Williams, who after rendering useful service in South Wales joined the Indian Survey, and his name was given in the "Return of Geological Assistants employed on the Geological Survey of England and Wales", which de la Beche made in June 1839. It will be noted that he wrote of the "Survey of England and Wales", although at the time he had only had authority to work in South Wales.

The "Return" for September 1839 contained *two* names, for Josiah Rees had been appointed at a salary of five shillings a day, and in December, when de la Beche submitted his estimates for the coming year, he budgeted for *four* assistants and a total expenditure of £1,400, while in the following year he budgeted for *six*, and a total expenditure of £1,900 —but the question of the possible limit to the duration of the Survey was not raised again, and before the work in South Wales was completed de la Beche was seeking permission to extend his operations into the Forest of Dean!

Hydrogenation of Oils by the Continuous Process

V. T. Athavale and S. K. K. Jatkar have recently carried out a detailed study of hydrogenation of ethyl oleate using nickel-carbonate kieselguhr catalyst (*J. Indian Inst. Sci.*, **21**, A, Part 25, 1938) and show a definite advance on previously recorded results. Iodine values, refractive indices and dispersions were determined on a number of samples of hydrogenated ethyl oleate, and results are recorded graphically. Contrary to expectation, iodine values did not vary linearly with refractive index in the initial stages of hydrogenation, but only after the iodine value had fallen by about twenty-five per cent. Comparison of refractive index and dispersion values of samples hydrogenated at different temperatures and with different rates of flow of ethyl oleate over the catalyst showed that dispersions of samples having almost identical refractive indices vary considerably. Similarly, it was found that samples having the same iodine value had dissimilar dispersions, thus indicating the formation of oleic acid during the reaction. A study of the effect of temperature on the velocity of hydrogenation at a fixed rate of flow of ethyl oleate over the catalyst further revealed a marked difference in dispersion values of samples hydrogenated at low temperatures and the conclusion was, therefore, reached that the isomers of oleic acid are formed because of the low activity for hydrogenation of the catalyst at low temperatures.

Interconnected with this research a further series of experiments were undertaken by the same authors (*J. Indian Inst. Sci.*, **21**, A, Part 26, 1938). Earlier work had pointed to the possibility that variations in velocity coefficients of hydrogenation of oils might be due not only to differences in composition of the oils, but equally to differences in the heterogeneity of the catalyst surface. Consequently, a study was undertaken of the velocity coefficients for the hydrogenation of ground-nut oil in the presence of nickel-carbonate-kieselguhr, unsupported nickel-carbonate, nickel-hydroxide-silica gel and nickel-peroxide-kieselguhr catalysts. A comparison was then made with the velocity coefficients of hydrogenation of the same oil over a nickel-wire catalyst. Velocity coefficients (K) were calculated from the equation:

$$K = \frac{2{\cdot}3}{t} \log \frac{a}{(a - x)};$$

where x is the percentage conversion at a given rate and t is the time of contact. This velocity coefficient was further corrected for the effect of absorption expressed as $K = K^1 (\text{rate})^{\frac{1}{n}}$, where K^1 is the corrected velocity coefficient. By plotting the value K^1 for different samples of oil against temperature, curves showing a maximum at 150° were obtained. This appeared to depend upon the percentage of olein in the oil and its selective hydrogenation at that temperature.

Science News a Century Ago

Researches on the Chemical Equivalents

ON February 14, 1839, Richard Phillips (1778–1851) who from 1839 until his death was chemist and curator of the Museum of Practical Geology, read a paper to the Royal Society entitled "Researches on the Chemical Equivalents of Certain Bodies". The paper was the result of a series of experiments made to test the truth of the theory of Dr. Prout and Dr. Thomson "that all atomic weights are simple multiples of hydrogen", a theory which the late Dr. Turner said was untenable. Turner having adopted the number 108 as the equivalent of silver, Phillips had selected this element as the basis for his inquiry into the equivalent numbers of chlorine and some other elementary gases. From his experiments, the author concluded that no material, and even scarcely any appreciable, error, could arise from considering the equivalent numbers of hydrogen, oxygen, nitrogen and chlorine as being 1, 8, 14 and 36 respectively.

Ehrenberg awarded the Wollaston Medal

AT the anniversary meeting of the Geological Society on February 15, 1839, the Wollaston Medal was handed to the Chevalier Bunsen for transmission to Prof. Christian Gottfried Ehrenberg, of Berlin, to whom it had been awarded for his discoveries respecting fossil Infusoria. "These discoveries," said Dr. Whewell, when handing the medal to Bunsen, "eminently striking and curious to all intelligent persons, are full of the most lively interests for geologists." They were, he added, a just reward of Prof. Ehrenberg's merits, "since he had prepared himself for this success by a profound study of natural history, by practical and scrutinizing researches, and by extensive and enterprising travels". In his reply, Bunsen said that the honour accorded "will be deeply felt by the whole literary public of Germany; it will, I trust, form a new link in that intellectual union between the two great and enlightened nations, which have so many objects of warm and deep sympathy; a union which must become every day more and more intimate, and prove productive of the most beneficial consequences, not only for the progress of science in the whole range of human intellect, but for the welfare of humanity at large".

Steel-making in India

DURING the discussion of a paper "On the Differences between the European and Indian Methods of Making Steel", at a meeting of the Asiatic Society on February 16, 1839, Mr. Heath, who had lately returned from the East, described the operations of the natives of India in manufacturing iron and steel. The ore used, he said, was the magnetic oxide of iron combined with quartz in the proportion of fifty-two of oxide to forty-eight of quartz, which occurred in the district of Salem. The ore was prepared by stamping and washing. The furnace was built of clay, charcoal was used as fuel, and the bellows were made of goat skins. The melting took about four hours and the product was hammered into bars. To convert the iron to steel, it was cut into small pieces and placed in crucibles with the dried wood of *Cassia auriculata* and a few green leaves of *Asclepias gigantia*.

Societies and Academies

Paris

Academy of Sciences (*C.R.*, **208**, 133–236, Jan. 16, 1939).

E. BOREL: A continuous problem analogous to a card game.

M. MOLLIARD and R. ÉCHEVIN: Does the nature of the food affect the reserves [of plants]? Radish and viper's grass grown aseptically produce the same reserves whether lævulose or glucose be applied to their roots.

A. GOSSET, R. JAHIEL and MME. S. DELAUNAY: Study of the evolutionary cycle of pneumonic illness in the rabbit, by local anaphylaxy, starting with endogenous proteins.

C. E. DIEULEFAIT: Moments of hypergeometric probabilities.

P. LÉVY: Division of a segment by a point chosen at random.

E. J. GUMBEL: Values of position of an aleatory variable.

P. VINCENSINI: A transformation of angle congruences of constant focal planes.

C. EHRESMANN: Paratactic congruences and parallelisms in projective spaces.

D. S. MITRINOVITCH: Theorem on Riccarti's equation.

J. MARCINKIEWICZ: Remark on M. Besikowitch's spaces.

C.-T. CHUANG: Holomorph functions in the *cercle unité*.

B. KWAL: Some relativistic generalizations of the fundamental equations of analytical mechanics.

R. GOUDEY: Measurements of the intensity of gravity in France during the year 1938.

G. PETIAU: Electromagnetic equations of the theory of the photon.

J. BASSET: Determination, under pressures of 1–11,000 kgm./cm², of an isotherm of naphthalene tetrahydride passing from the liquid to the solid state.

A. RASKIN: Construction of a high-tension generator with large output. An output of 800 microamp. can be obtained; the voltage, which is limited by local conditions, is 400,000.

G. REBOUL and F. PERRIER: A peculiarity of air ionized by X-rays. An effect can be detected several hours after the exciting rays are cut off, due apparently to 'large' ions which in number are about a million times fewer than those produced by the same X-rays.

N. KÜRTI, P. LAÏNÉ and F. SIMON: Adiabatic demagnetization starting from temperatures obtained with solid hydrogen. Using the great magnet of the Academy of Sciences, with a field of 29 kilogauss, a temperature of 0·36° K. was obtained in one stage with iron alum. Thus it is possible to dispense with liquid helium for work below 1° K. and hence the equipment required is simplified.

R. FORRER: Relations between the Curie point, orbital moment and crystal lattice.

L. NÉEL: Specific heat and fluctuations of the molecular field.

E. RENCKER: Properties of vitreous phenol phthalein.

L. GROVEN: Contribution to the study of the X-rays emitted in the discharge between external electrodes with maintained waves [of potential].

MLLE. M.-L. DELWAULLE, F. FRANÇOIS and J. WIEMANN: Study of the constitution of solutions of cadmium iodide; complete Raman spectrum of cadmium tetraiodide.

J. CATHALA and J. CLUZEL : Continuation of the spectrophotometric study of the slow hydrolysis of ferric salts.

P. BASTIEN : Influence of *p*H of acid solutions on the evolution as a function of time of the 'pickle' brittleness of extra soft annealed steel.

J. FARINEAU : Electronic structure of certain copper-aluminium alloys.

J. BOUGAULT, E. CATTELAIN and P. CHABRIER : Nickel amalgams. Nickel can be amalgamated in the presence of nascent hydrogen, which seems to act as a catalyst.

R. CHAUVENET : Combinations of beryllium nitrate and the alkali nitrates.

MLLE. J. BRIGANDO : Study of ferricyanic, cobalticyanic and chromocyanic acids.

G. COURTOIS : Fusibility of mixtures of pure anhydrous sodium sulphide and sodium sulphate.

A.-A. SANFOURCHE : Magnesium hydroxy-apatite.

G. VAVON, J. CALIN and J. FOURCHIER : Action of halogen derivatives on magnesium couples.

R. JOUAN : A new method of production of crystals on which physical measurements can be made. A 'seed' crystal is supported in a supersaturated solution on artificial silk gauze carried on an oscillating glass frame.

L. BERTHOIS : Remarks on the origin of tourmaline in sedimentary rocks.

G. CHOUBERT : The Cretaceous of eastern Morocco.

M. THORAL and B. GÈZE : Structure of the western region of the southern slope of the Black Mountains (Aude-Hérault).

R. HUMERY : Piezometric surface of a sheet of water feeding any number whatever of artesian wells. A theoretical investigation.

J. MOUSSIEGT : Measurements of the conductibility and ionization of the atmosphere in the Alps (work of the Sanatorium des Étudiants de France, and of the chair of therapeutic hydrology and climatology of the Faculty of Medicine of Lyons).

G. GRENET and MME. P. QUENEY : Comparison of electromagnetic seismographs.

H. HUMBERT : An archaic genus of Cucurbitaceæ of Madagascar.

G. MANGENOT : Action of colchicine on plant cells. Colchicine immediately prevents cell proliferation though growth continues. This occurs before the appearance of giant nuclei.

A. MICHALSKI and F.-X. SKUPIEŃSKI : Ecological researches on *Physarum didermoides* Rost, an endospore myxomycete.

R. SOUÈGES : Embryogeny of the Cucurbitaceæ : development of the embryo of *Bryonia dioica* Jacq.

J. REBOUL : General theory of the action of X-rays on biological elements. A revision of Crowther's formula is proposed.

M. PIÉRY, J. ENSELME, C. PESCHIERA and MLLE. M.-A. NOVA : Effect of the oxygen saturation of arterial blood on the production of lactic acid by striated muscle.

A. BESREDKA : Antidiphtheric serotherapy by the cutaneous route. Antidiphtheric serum on the scarified skin of the rabbit is effective, even if applied several hours after penetration of the toxin.

P. LEPESME : Influence of temperature and humidity on the pathogeny of the aspergillosis of Acridians.

Geneva

Physical and Natural History Society (November 17, 1938).

A. PICTET : Geographical distribution of organisms and the problem of transformism. Studies in the field and laboratory suggest that there is a relationship between geographical separation and racial chromosomal constitution, separation having created germinal differences. This view puts the process of transformism back to early geological times before the continents were separated.

M. PERROT : The chromosomes of *Archelix* and of *Alabastrina Alabastrites* Michaud. The chromosome number of *A. Alabastrites* is different from that in the three other species of Archelix. It is concluded that the genus *Alabastrina* of Kobelt is artificial, since it contains species related to *Archelix* and others which should be placed in another group.

J.-L. PERROT and M. PERROT : Chromosomes of five species of *Limnea*. Chromosome number of *L. auricularia, ovata* and *peregra* is 17 ; that of *L. palustris* and *stagnalis* is 18. This confirms the classical arrangement of the first three species in the subgenus *Radix*. The parallelism between the chromosomal homogeneity and the great resemblance of conchological and anatomical characters is also emphasized.

J.-L. PERROT : Is self-fertilization possible in *Eulota fruticum* Müller ? In contrast to a nearly related species, *E. similaris stimpsoni*, self-fertilization is not possible.

M. L. MISCH and A. J. A. VAN DER WYK : Structure of oxamide. X-ray study of crystallized oxamide shows that it belongs to the triclinic system. Cohesion in the *ac* plane is very great ; this accounts for the special physical properties of oxamide.

December 1, 1938.

A. PICTET : Localization of physiological races of Lepidoptera in the Swiss National Park as a function of altitude and of the flora. The topography and diversity of soils and flora of the Park have localized individuals (of *Nemeophila plantaginis*) in autonomous stations, where they retain their own physiological and genetic characteristics from year to year.

H. BRANDT and W. SCHUSSELE : Researches on vitamin C during athletic effort. Vitamin C, or more strictly the reducing power of the urine in the dichlorophenol-indophenol reaction, may increase or decrease after exertion. The same subject always gives the same reaction, which appears to be a constitutional factor.

December 15, 1938

B. SUSZ and E. BRINER : Absorption by benzoic aldehyde in the violet and the near ultra-violet. The coefficient of extinction between 3820 A. and 4060 A. has been measured, after elimination by extrapolation of the effect of the benzoic acid always present in small concentration.

P. ROSSIER : Choice of the resistance of the induced circuit in measurements with the ballistic galvanometer. Case of critical damping when the galvanometer deflection is a maximum.

F. CHODAT : Study of chloroplasts by the method of formation of starch *in vivo*. Transformation of starch formed by the chloroplasts, by warming, permits the demonstration of the heterogeneous structure of the chloroplasts ; after this treatment they show a series of granulations.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, February 13

UNIVERSITY OF LEEDS, at 5.15.—Prof. J. E. Littlewood: "Results in the Theory of Prime Numbers".*

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.30.—Heath Clark Lectures on "Europe and West Africa: Some Problems of Adjustment" to be given by various lectures (succeeding lectures on February 15, 17, 20, 22 and 24).*

ROYAL SOCIETY OF ARTS, at 8.—Sir Gilbert Morgan, F.R.S.: "Achievements of British Chemical Industry in the last Twenty-five Years" (Cantor Lectures. Succeeding lectures on February 20 and 27).

Tuesday, February 14

UNIVERSITY COLLEGE, LONDON, at 5.15.—Prof. S. R. K. Glanville: "The Use of Museums. (2) The Archæological Museum".*

Thursday, February 16

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 7.45.—Dr. C. Wilcocks: "Tuberculosis in Natives of Tropical and Sub-Tropical Regions."

Friday, February 17

INSTITUTION OF CHEMICAL ENGINEERS (at the Hotel Victoria, London), at 11.—Annual Corporate Meeting. Dr. William Cullen: "My Fifty Years of the Explosives Industry" (Presidential Address).

UNIVERSITY OF LONDON INSTITUTE OF EDUCATION (in association with the SOCIETY FOR THE PROTECTION OF SCIENCE AND LEARNING), at 5.30.—Prof. J. B. S. Haldane, F.R.S.: "Race in Fact and Theory".*

INSTITUTION OF MECHANICAL ENGINEERS, at 5.30.—Annual General Meeting.
W. H. Orr: "The Modern Paper-making Machine".

INSTITUTION OF CIVIL ENGINEERS (GLASGOW SECTION), at 7.30.—W. A. Tookey: "Dugald Clerk and the Gas-Engine: His Life and Work" (Dugald Clerk Lecture).

ROYAL INSTITUTION, at 9.—Prof. G. T. R. Hill: "Aeroplane Controls".

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

DEMONSTRATOR in the Engineering Test Laboratory in the Royal Naval Engineering College, Devonport—The Director, Education Department, Admiralty, London, S.W.1 (February 11).

ASSISTANT (grade III) in the External Ballistic Department of the Ordnance Board, Woolwich—The Secretary, Ordnance Board, Royal Arsenal, Woolwich, S.E.18 (February 14).

JUNIOR LECTURER IN CIVIL ENGINEERING in the University of the Witwatersrand—The Secretary, High Commissioner, South Africa House, Trafalgar Square, W.C.2 (February 22).

SENIOR TECHNICAL OFFICER in the Radio Department of the Royal Aircraft Establishment, South Farnborough, Hants—(February 25).

DIRECTOR OF SUGAR BEET RESEARCH—The Secretary, Sugar Commission, Queen Anne's Chambers, 41, Tothill Street, London, S.W.1 (February 28).

LECTURER IN MATHEMATICS in the University of Aberdeen—The Secretary (March 7).

JUNIOR TECHNICAL ASSISTANT (electrical engineering) in the Royal Mint—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1 (March 9).

READER IN CHEMICAL ENGINEERING in the University of Bombay—The High Commissioner for India, Aldwych, London, W.C.2.

ASSISTANT MYCOLOGIST at the Imperial Mycological Institute, Ferry Lane, Kew, Surrey—The Director.

Reports and other Publications

(*not included in the monthly Books Supplement*)

Other Countries

Canada: Department of Mines and Resources, Mines and Geology Branch: National Museum of Canada. Bulletin No. 90 (Anthropological Series, No. 23): The Sarcee Indians of Alberta. By Diamond Jenness. Pp. vii+98. 25 cents. Bulletin No. 91: Annual Report of the National Museum for the Fiscal Year 1937–38. Pp. 20. 10 cents. (Ottawa: King's Printer.) [231

Canada: Department of Mines and Resources, Mines and Geology Branch: Bureau of Geology and Topography. Geological Survey Memoir 210: Rice Lake—Gold Lake Area, Southeastern Manitoba. By C. H. Stockwell. (No. 2444.) Pp. 79 + 3 plates. 25 cents. Geological Survey Memoir 214: Geology and Mineral Deposits of Freegold Mountain, Carmacks District, Yukon. By J. R. Johnston. (No. 2446.) Pp. ii+21. 10 cents. Geological Survey Memoir 217: Laberge Map-Area, Yukon. By H. S. Bostock and E. J. Lees. (No. 2449.) Pp. 11+32+3 plates. 25 cents. (Ottawa: King's Printer.) [231

Annual Report of the All-India Institute of Hygiene and Public Health, Calcutta, 1937. Pp. 64. (Calcutta: Government of India Press.) [231

Meddelelser fra Kommissionen for Danmarks Fiskeri- og Havundersøgelser. Serie Fiskeri, Bind 10, Nr. 6: 125 Salmon from West Jutland. By C. V. Otterstrøm. Pp. 26. (København: C. A. Reitzels Forlag.) 1.25 kr. [231

Journal of the Indian Institute of Science. Vol. 22A. Part 1: Supersonic Velocity in Gases and Vapours. Part 4: Measurement of the Absolute Frequency of Piezoelectric Quartz Oscillators. By S. K. Kulkarni Jutkar. Pp. 18. (Bangalore: Indian Institute of Science.) 1.4 rupees. [231

Michigan State College of Agriculture and Applied Science. Agricultural Experiment Station Report, Two Years ended June 30, 1938. Pp. 48. (East Lansing, Mich.: Michigan State College of Agriculture and Applied Science.) [231

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 122: The Establishment of Pastures on Deep Sands in the Upper South-East of South Australia. By Dr. H. C. Trumble, C. M. Donald and C. A. Neal Smith; with an Appendix on the Rôle of Seed Inoculation, by T. H. Strong. Pp. 24+4 plates. Pamphlet No. 85: A Chemical Study of some Australian Fish. By W. G. Jowett and Dr. W. Davies. Pp. 40. Pamphlet No. 86: A Study of the Pulping Properties of Three Trees of *E. sieberiana*, using the Sulphate Process. By J. C. Cavanagh, H. E. Dadswell, A. W. Mackney and Dr. T. M. Reynolds. (Division of Forest Products: Technical Paper No. 29.) Pp. 32+1 plate. Pamphlet No. 87: The Mechanical Properties of South Australian Plantation-Grown *Pinus radiata* D. Don. By Ian Langlands. (Division of Forest Products: Technical Paper No. 30.) Pp. 53+2 plates. (Melbourne: Government Printer.) [231

Carnegie Institution of Washington. Publication No. 504: The American Species of Crepis; their Interrelationships and Distribution as affected by Polyploidy and Apomixis. By E. B. Babcock and G. L. Stebbins, Jr. Pp. iii+199+3 plates. (Washington, D.C.: Carnegie Institution.) [231

U.S. Department of Agriculture. Circular No. 494: The Texas Leaf-Cutting Ant and its Control. By E. V. Walter, Lee Seaton and A. A. Matthewson. Pp. 19. (Washington, D.C.: Government Printing Office.) 5 cents. [231

U.S. Treasury Department: Public Health Service. Studies on Drug Addiction; with Special Reference to Chemical Structure of Opium Derivatives and Allied Synthetic Substances and their Physiological Action. By Lyndon F. Small, Nathan B. Eddy, Erich Mosettig and C. K. Himmelsbach. (Supplement No. 138 to the Public Health Reports.) Pp. viii+143. (Washington, D.C.: Government Printing Office.) 60 cents. [231

Madras Fisheries Department. Administration Report for the Year 1936–37. By Diwan Bahadur Dr. B. Sundara Raj. Pp. iii+66. 8 annas. The Fishing Methods of the Madras Presidency. Part 2: The Malabar Coast. By James Hornell. (Report No. 1 of 1937. Madras Fisheries Bulletin, Vol. No. 27.) Pp. 69+11 plates. (Madras: Government Press.) 1.2 rupees. [231

Annuaire pour l'an 1939 publié par le Bureau des Longitudes. Pp. viii+584+A26+B22+C54. (Paris: Gauthier-Villars.) 25 francs. [231

Comité National français et Comité National marocain de Géodésie et Géophysique. Années 1933, 1934, 1935, 1936. Compte rendu publié par le Secrétaire général du Comité français, G. Perrier. Pp. 408. (Paris: Secrétaire général du Comité français.) [231

Commonwealth of Australia. Report of the Ninth Australian Cancer Conference held at Sydney, 5th–8th April 1938. Pp. 55. (Canberra: Government Printer.) [231

Smithsonian Miscellaneous Collections. Vol. 97, No. 8: Drawings by George Gibbs in the Far Northwest, 1849–1851. By David I. Bushnell, Jr. (Publication 3485.) Pp. iii+28+18 plates. Vol. 97, No. 11: An Assay Method for Growth-Promoting Substances utilizing Straight Growth of the *Avena* coleoptile. By Robert L. Weintraub. (Publication 3488.) Pp. ii+10+1 plate. (Washington, D.C.: Smithsonian Institution.) [231

Institut International de Coopération intellectuelle. Études et recherches sur les phytohormones. Première réunion organisée en collaboration avec l'Union Internationale des Sciences biologiques, Paris, 1 et 2 octobre 1937. Pp. xiv+126. 35 francs. Les déterminations physico-chimiques des poids moléculaires et atomiques des gaz. Réunion organisée en collaboration avec l'Union Internationale de Chimie et l'Union Internationale de Physique, Neuchatel, 17 et 18 décembre 1938. Pp. xiii+192. 45 francs. (Paris: Institut International de Coopération intellectuelle.) [231

Archivos de la Escuela de Farmacia de la Facultad de Ciencias médicas de Córdoba. No. 5: Musgos de la República Argentina; Contribución al conocimiento de los Musgos de la Provincia de Córdoba, 1. Por el Dr. Carlos Curt Hosseus. Pp. 42. No. 7: Contribución al conocimiento de la flora Briofita del sur de Chile. (a) Parte sistemática, por T. Herzog; (b) Parte fisiográfica, por Carlos Curt Hosseus. Pp. 95. No. 8: Musgos de la República Argentina; Contribución al conocimiento de los Musgos de la Provincia de Córdoba, 2. Por el Dr. Carlos Curt Hosseus. Pp. 58. (Córdoba: Facultad de Ciencias médicas.) [231

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 25: The Clinging Power of Single Cotton Fibres in relation to their Physical Properties. By Dr. K. R. Sen and Dr. N. Ahmad. Pp. 24. (Bombay: Indian Central Cotton Committee.) 8 annas. [241